About the Cover

Pictured on the cover are examples of leaves of four different species of oak native to the Austin area. The names of these oaks, as arranged on the cover, are:

Blackjack Oak *Quercus marilandica*	Spanish Oak, or Texas Oak *Quercus texana*
Plateau Live Oak *Quercus fusiformis*	Post Oak *Quercus stellata*

Source: Lynch & McGowan, 1981
Native & Naturalized Woody Plants of Austin & the Hill Country

City of Austin

Frank C. Cooksey
MAYOR

John Treviño
MAYOR PRO TEM

COUNCIL MEMBERS
Mark Rose
Smoot Carl-Mitchell
Sally Shipman
George Humphrey
Charles E. Urdy

Jorge Carrasco
CITY MANAGER

AUSTIN AREA ENVIRONMENTAL HANDBOOK
DEPARTMENT OF ENVIRONMENTAL PROTECTION
April, 1987

The Austin Area Environmental Handbook is a publication of the City of Austin, Department of Environmental Protection, Environmental Education Program. The handbook was written and compiled by Joey Crumley, Environmental Specialist, and reviewed by other staff members of the Department of Environmental Protection. The purpose of the handbook is threefold:

- to provide a general description of the natural environmental setting of the Austin area
- to assess the effects of increased urbanization on environmental quality and discuss the state of some important natural resources
- to describe existing environmental protection measures and those currently under consideration that are applicable to the Austin area

The handbook is intended to be a non-technical guide. Some technical terms necessary in the presentation of the material are explained in the text, and a complete glossary of technical terms is provided.

For additional information relating to the natural resources of the Austin area or to environmental quality, please contact the City of Austin, Department of Environmental Protection, at 499-2550. The Department of Environmental Protection is located in the Municipal Annex Building, at 301 West 2nd Street.

Austan S Librach

Austan Librach
Director
Department of Environmental Protection

April, 1987

AUSTIN AREA ENVIRONMENTAL HANDBOOK

TABLE OF CONTENTS

LIST OF FIGURES

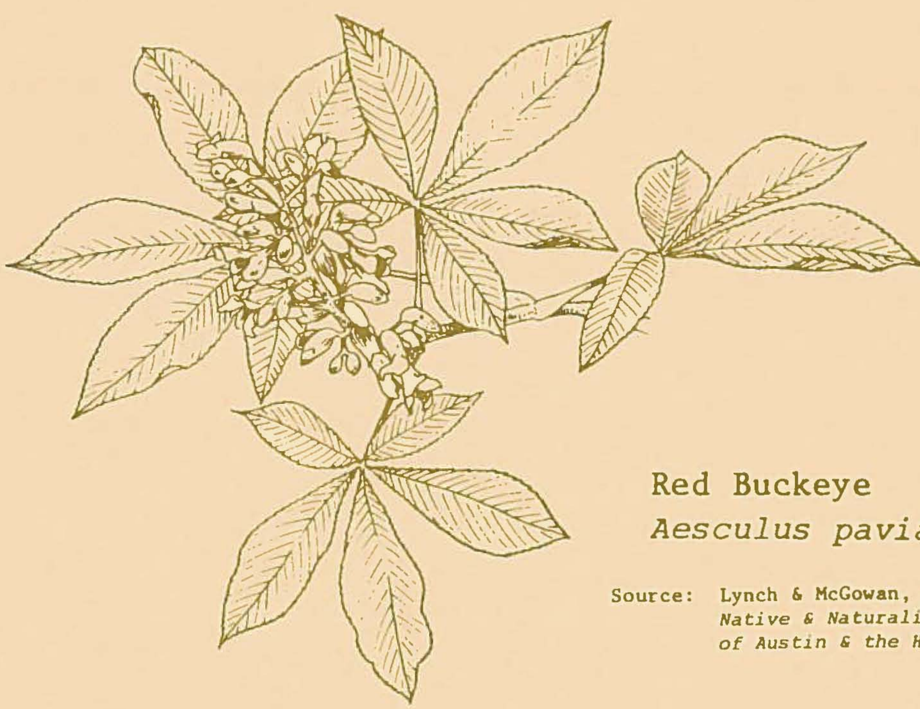
LIST OF TABLES

1.0 INTRODUCTION

The study area of this report is shown in Figure 1, which illustrates the location of Austin in relation to surrounding municipalities, major surface water features, and important transportation linkages. From an environmental standpoint, Austin's location must be considered within this larger geographical context, because some sources of environmental contamination and some environmental protection measures may be regional in scope.

Austin is the capital of Texas and the county seat of Travis County. The Austin Metropolitan Statistical Area (MSA) includes Travis, Williamson, and Hays Counties. Most of the corporate limits of the City of Austin are located within Travis County, but a small portion of the corporate limits are located within Williamson County and Hays County. The five-mile extraterritorial jurisdiction (ETJ) of the City of Austin covers most of Travis County and now extends into Williamson, Hays, Caldwell, and Bastrop Counties.

Largely due to its many natural and cultural amenities, Austin has become one of the fastest growing cities in the nation. As indicated in Table 1, the areal size of Austin has increased substantially over the last several years, as well as the population, as shown in Table 2. According to City of Austin Department of Planning and Growth Management projections, the population of the Austin area will approach the one million figure by the year 2000. This statistic has a bearing on environmental planning, because increased urbanization can have negative impacts on environmental quality, and even result in the permanent loss of some important or unique natural resources.



Red Buckeye
Aesculus pavia

Source: Lynch & McGowan, 1981
Native & Naturalized Woody Plants of Austin & the Hill Country

Figure 1
STUDY AREA

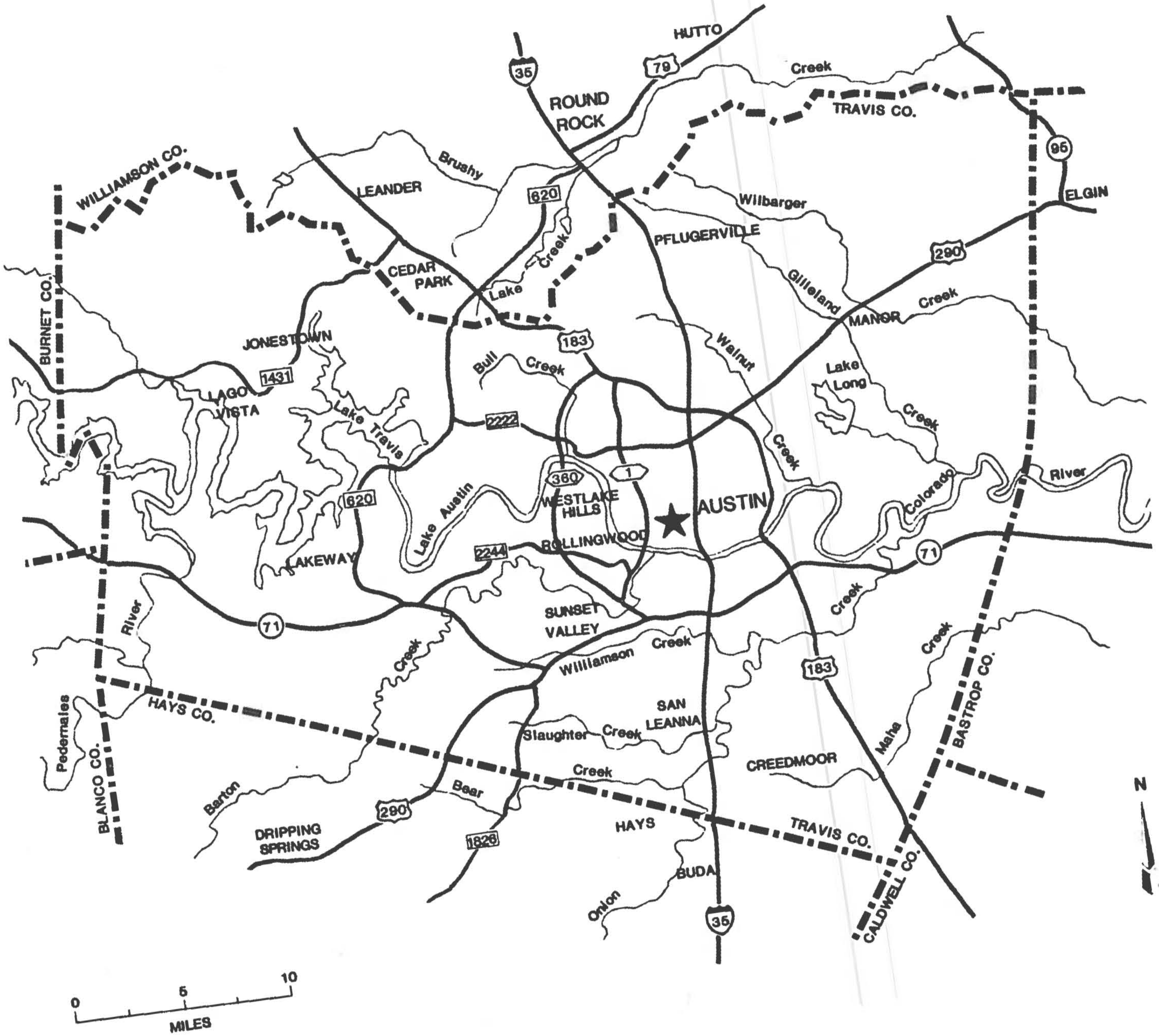


Table 1
AREAL GROWTH OF THE CITY OF AUSTIN

Year	Area (in square miles)
1839	1.00
1900	16.50
1910	16.50
1920	16.50
1930	20.41
1940	30.85
1950	37.87
1960	55.80
1970	81.39
1975	108.90
1980	127.33 FP* 1.57 LP**
1981	128.35 FP 1.45 LP
1982	129.27 FP 5.48 LP
1983	137.52 FP 8.37 LP
1984	160.49 FP 39.49 LP
1985	183.35 FP 55.28 LP
1986	197.90 FP 67.29 LP

* Area under Full Purpose Annexation
** Area under Limited Purpose Annexation

Source: City of Austin
Department of Planning and Growth Management

Table 2
POPULATION GROWTH IN THE AUSTIN AREA

Year	City of Austin	Travis County
1940	87,930	111,053
1950	132,459	160,980
1960	186,545	212,136
1970	251,808	295,516
1980	343,390	416,315
1984	436,188	498,904
1985	470,067	520,285
1986	489,849	573,919

Source: City of Austin
Department of Planning and Growth Management

2.0 ENVIRONMENTAL SETTING

The people of Austin are truly fortunate to be located in such a rich and favorable environmental setting. There are few places anywhere that, in the same amount of area, offer such a noticeable diversity in terrains, soils, and native plants and animals. This section provides a general description of the physical location, climate, and natural resources of the Austin area.

Sideoats Grama
Bouteloua curtipendula

Source: Gould, 1978
Common Texas Grasses

2.1 Physical Location and Climate

Austin is located where the Colorado River crosses the Balcones Escarpment, which delineates the boundary between the Hill Country of the Edwards Plateau and the Blackland Prairie of the Gulf Coastal Plain (Figure 2). Early settlers were attracted to this area because of the abundance of water and the diversity of natural resources.

The geographical coordinates of Austin, at Robert Mueller Municipal Airport, are 30°18′N, 97°42′W. Austin's subtropical latitude and its proximity to the Gulf of Mexico are important climatic determinants.

The climate of the Austin area is classified as humid subtropical. Daytime temperatures in summer are hot, but summer nights are usually pleasant. Winters are relatively mild, with below freezing temperatures occurring on an average of about 25 days each year. The last freezing temperature in spring usually occurs in early March, and the first freezing temperature in autumn usually occurs in late November. Sharp drops in temperature can occur during the winter months in connection with cold fronts, or "northers," but cold spells are usually of short duration, seldom lasting more than two or three days.

Precipitation is fairly evenly distributed throughout the year, as indicated in Table 3. Summer precipitation is usually associated with surface heating, which can support the development of late afternoon thunderstorms that can produce large amounts of rain in short periods of time. Thunderstorms can occur in the Austin area virtually any time of the year, and some of the highest intensity thunderstorms on the continent occur in the Austin area. In the late summer and early autumn, the remnants of tropical storms from the Gulf of Mexico can bring heavy rains into the Austin area. Frontal activity can bring precipitation in varying amounts between late autumn and early spring, but most of the precipitation in winter consists of light rain. Snow is not a significant source of moisture, and usually melts as rapidly as it falls; the Austin area may experience several seasons in succession with no measurable snowfall.

Prevailing winds are southerly; however, in winter, northerly winds are about as frequent as those from the south. Blowing dust occurs occasionally in spring, but visibility rarely drops substantially, and then only for a few hours. Winds may be strong and gusty near thunderstorms, but destructive winds are relatively infrequent.

Figure 2
PHYSICAL LOCATION OF AUSTIN

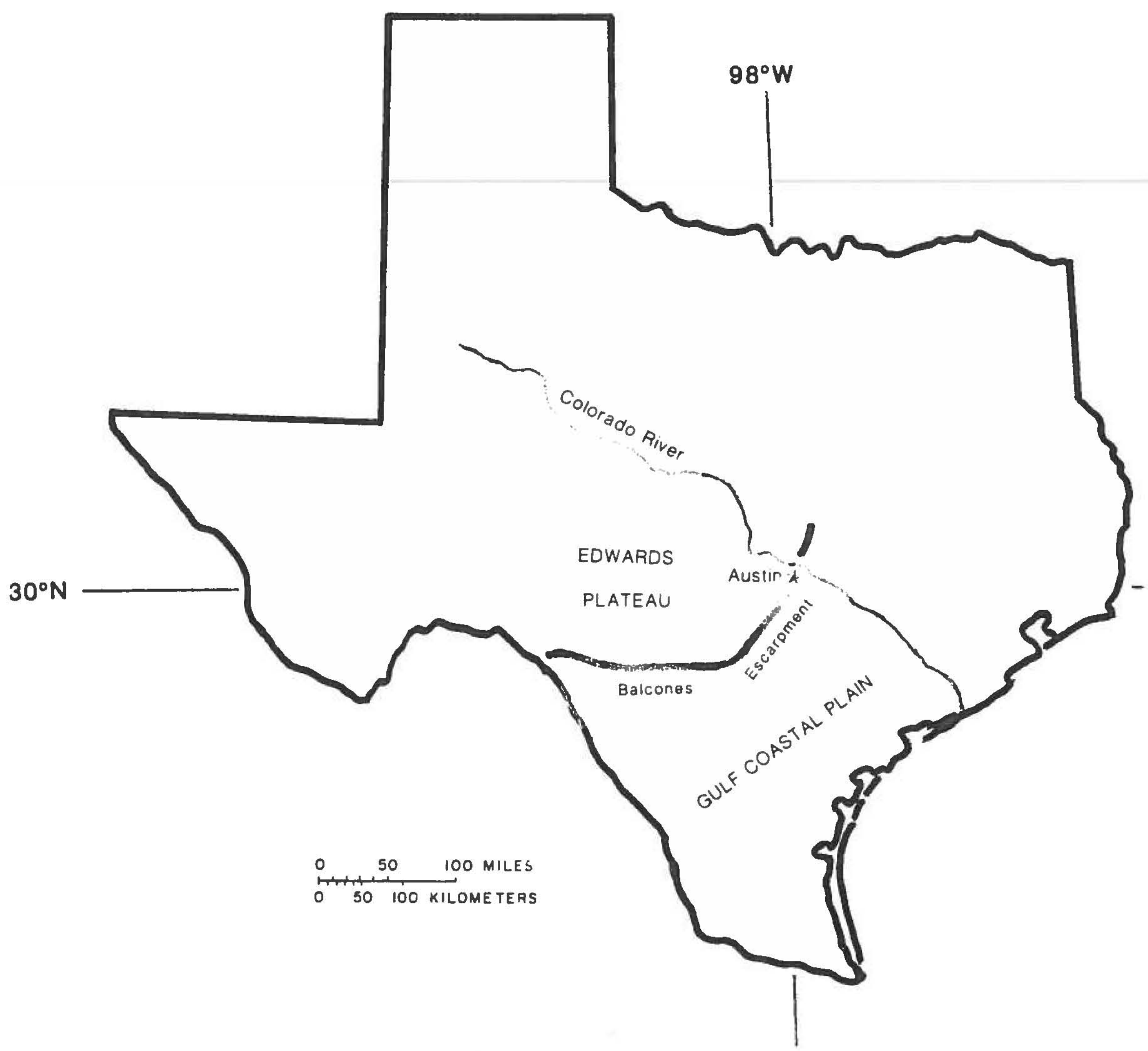


Table 3
CLIMATOLOGICAL DATA FOR AUSTIN, TEXAS

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TEMPERATURE (°F)													
Normal Daily Max.	59.4	64.1	71.7	79.0	84.7	91.6	95.4	95.3	89.3	80.8	69.2	62.8	78.6
Normal Daily Min.	38.8	42.2	49.3	58.3	65.1	71.5	73.9	73.7	69.1	58.7	48.1	41.4	57.5
Normal Monthly	49.1	53.2	60.5	68.7	74.9	81.6	84.7	84.5	79.2	69.8	58.7	52.1	
Record High	90	93	98	98	100	105	109	106	104	97	91	90	
(Year)	1971	1954	1971	1982	1984	1980	1954	1984	1985	1979	1951	1955	
Record Low	-2	7	18	35	43	53	64	61	41	32	20	10	
(Year)	1949	1951	1948	1973	1954	1970	1970	1967	1942	1957	1976	1983	
PRECIPITATION (in.)													
Rain													
Normal	1.60	2.49	1.68	3.11	4.19	3.06	1.89	2.24	3.60	3.38	2.20	2.06	31.5
Max. Monthly	7.94	6.39	6.03	9.93	9.98	14.96	10.54	8.90	8.11	12.31	7.91	5.91	
(Year)	1968	1958	1983	1957	1965	1981	1979	1974	1942	1960	1946	1944	
Min. Monthly	0.04	0.28	T	0.06	0.81	T	0.00	0.00	0.07	T	T	T	
(Year)	1971	1954	1972	1984	1960	1967	1962	1952	1947	1952	1970	1950	
Max. 24 hrs.	3.44	3.73	2.69	3.86	5.66	6.50	5.46	4.68	6.74	7.22	5.09	4.02	
(Year)	1965	1958	1980	1942	1979	1964	1961	1945	1973	1960	1974	1953	
Snow, Ice Pellets													
Max. Monthly	7.5	6.0	2.0								2.0	T	
(Year)	1985	1966	1965								1980	1983	
Max. 24 hrs.	7.0	6.0	2.0								2.0	T	
(Year)	1944	1966	1965								1980	1983	
MEAN SKY COVER (%)													
(for daylight hours)	63	60	61	63	61	52	47	47	50	48	53	59	55
WIND													
Mean Speed (mph)	9.8	10.2	10.9	10.6	9.7	9.3	8.4	7.9	8.0	8.1	9.0	9.2	9.2
Prevailing Direction	S	S	S	SSE	SSE	S	S	S	S	S	S	S	S
Peak Gust													
Speed (mph)	52	55	56	41	47	38	40	44	41	46	40	41	
Direction	N	NW	NW	N	N	SE	S	N	N	N	N	W	
(Year)	1985	1984	1984	1984	1985	1985	1985	1985	1985	1985	1984	1984	
RELATIVE HUMIDITY (%)													
Local Hour 00	72	71	71	75	80	79	74	73	78	75	76	73	75
06	78	79	79	82	88	88	87	86	86	83	82	79	83
12	60	58	56	58	60	56	50	50	56	55	58	59	56
18	57	52	49	53	57	53	46	46	55	55	59	58	53

Source: National Oceanic and Atmospheric Administration, 1986

2.2 Physical Geographic Regions

The natural landscape of the Austin area can be divided into different regions according to significant variations in physical geographic features, such as topography, surface geology, soils, and natural vegetation.

The topography of the Austin area is variable, ranging from nearly level in the eastern part of the area to hilly in the western part of the area, where some slopes may be quite steep. Elevations in Travis County range from 360 feet to 1330 feet above sea level, with a total relief of 970 feet (Figure 3).

Local geology is dominated by sedimentary rocks, including limestone, chalk, and clay. Alluvial deposits may be found in terraces of the Colorado River and its major tributaries, with younger alluvial material found in current floodplains. There are a few outcrops of igneous formations in the Austin area.

The surface geology provides parent material for a variety of soils in the Austin area. Soils can be classified according to particle size, into general categories of sand, silt, or clay. For example, sandy loam contains silt and clay, but mostly sand. Clay can either refer to a type of soil, or it can refer to a type of soft rock. In the soil classificiation system, series of related soils are arranged into associations. There are ten soil associations in Travis County, as shown in Figure 4. These soil associations are described in Table 4.

To a large extent, the type of vegetation found in a certain area is associated with soil characteristics. For example, some plants require the soil to be consistently moist, or some plants require a particular range of soil pH. Natural vegetation in the Austin area can be characterized by vegetative assemblages indicative of a particular physical environment, such as a floodplain, a rocky plateau, or a steep canyon head.

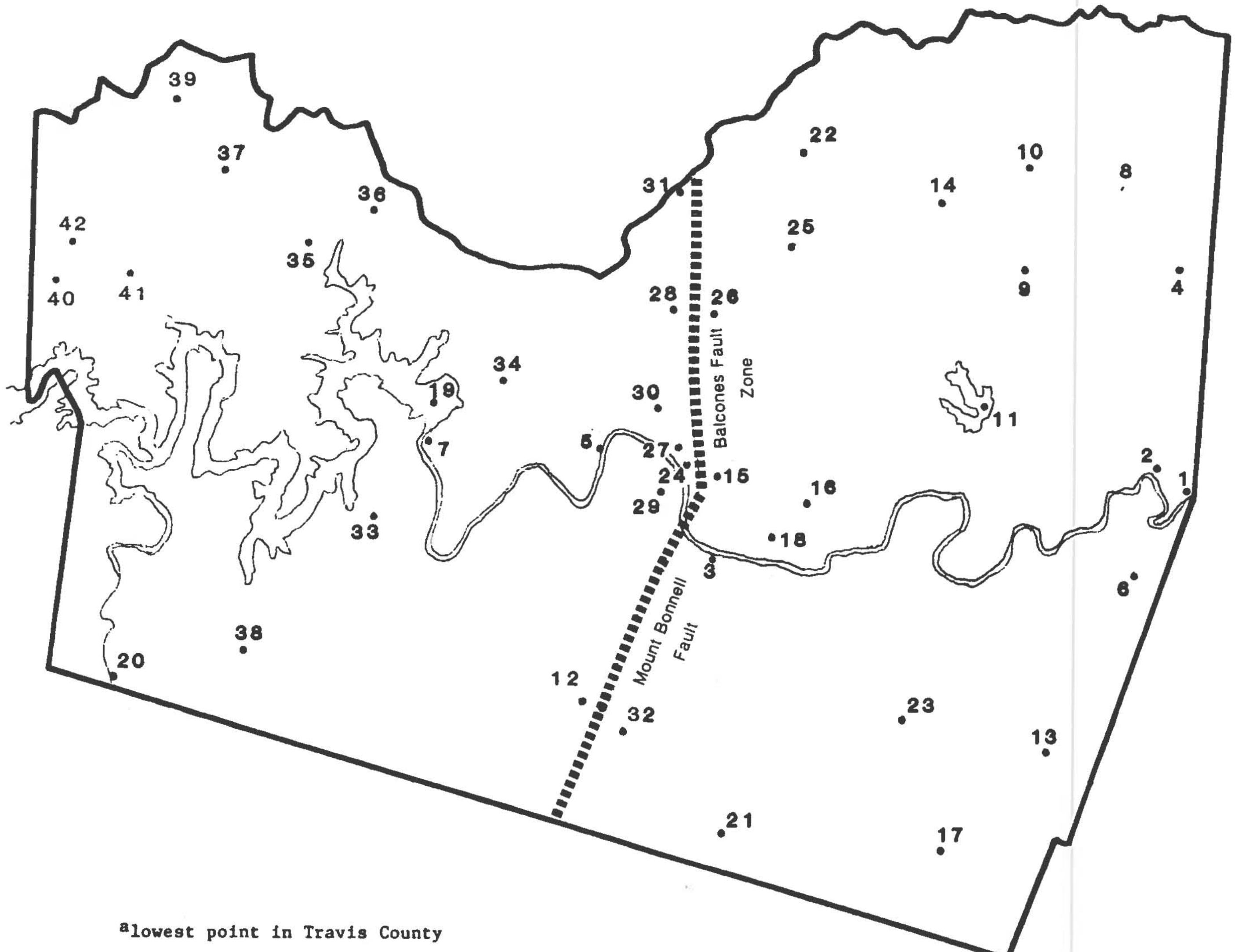
The Austin area extends over four physical geographic regions: the Edwards Plateau, the Rolling Prairie, the Blackland Prairie, and the terraces and floodplains of the Colorado River and its tributaries (Figure 5). These regions differ in topography, surface geology, soil types, and characteristic vegetative assemblages.

2.2.1 Edwards Plateau

The Edwards Plateau lies to the west of the Balcones Escarpment. The Edwards Plateau once extended unbroken all the way from the Balcones Escarpment to at least as far as the High Plains and the Stockton Plateau in West Texas. But much of the Edwards Plateau has been substantially dissected by surface streams, forming the Central Texas Hill Country. Many of the hill tops are similar in elevation, representing the remnants of the once unbroken plateau.

The Jollyville Plateau, located in northwestern Travis County and

Figure 3
SELECTED REFERENCE ELEVATIONS
Travis County



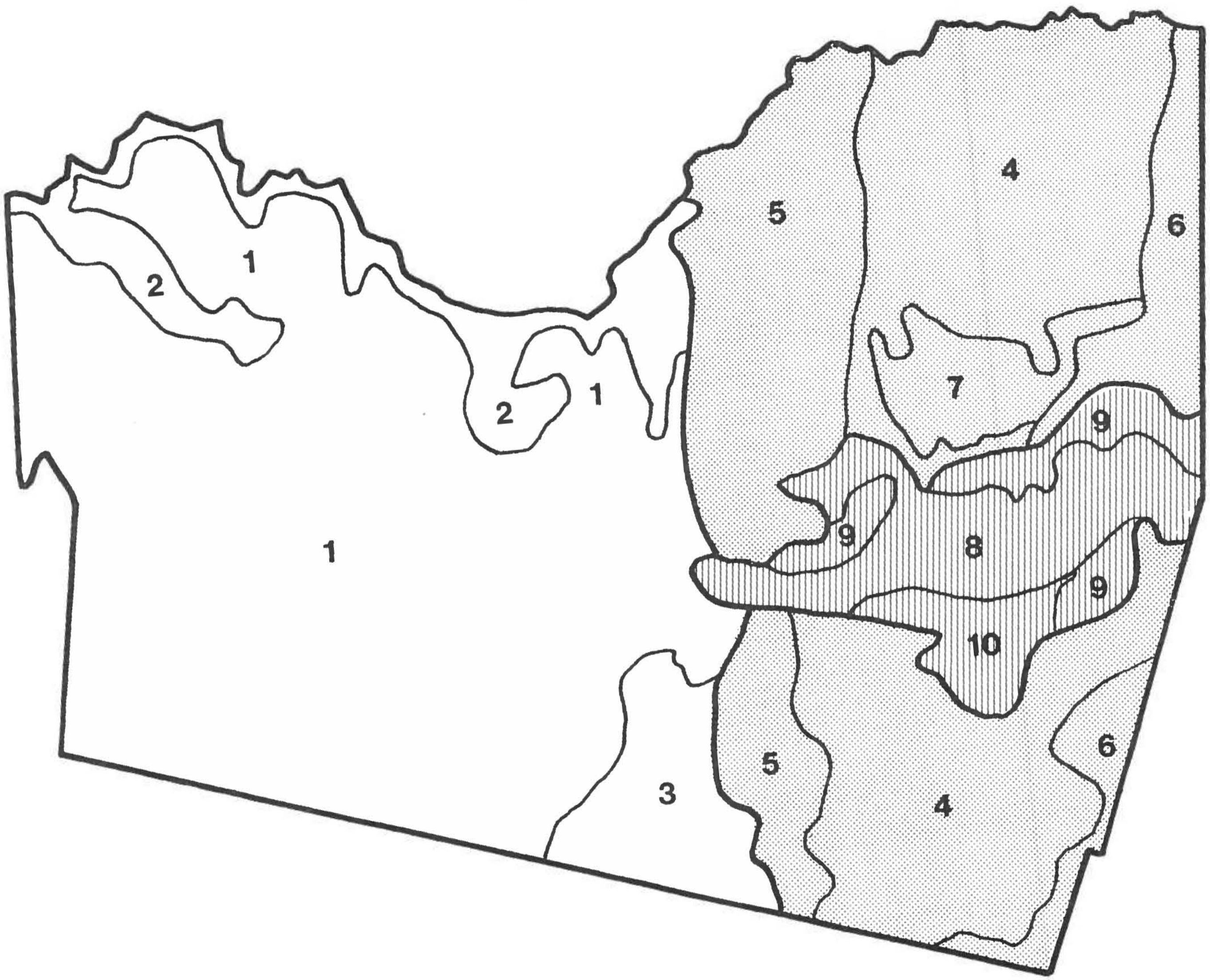
1 Colorado River, 360 ft.[a]
2 Weberville, 410 ft.
3 Town Lake, 428 ft.
4 Littig, 457 ft.
5 Lake Austin, 483 ft.
6 Garfield, 485 ft.
7 Low-water Crossing, 499 ft.
8 Kimbro, 524 ft.
9 Manor, 528 ft.
10 New Sweden, 550 ft.
11 Lake Long, 555 ft.
12 "Y" at Oak Hill, 575 ft.
13 Elroy, 598 ft.
14 Birds Nest Airfield, 614 ft.
15 Camp Mabry Headquarters, 620 ft.
16 Robert Mueller Municpal Airport, 621 ft.
17 Creedmoor, 633 ft.
18 State Capitol, 645 ft.
19 Lake Travis, 681 ft.
20 Hammett's Crossing, 692 ft.
21 Manchaca, 697 ft.
22 Pflugerville, 702 ft.
23 Pilot Knob, 711 ft.[b]
24 Mount Bonnell, 750 ft.
25 Austin Executive Airpark, 761 ft.
26 Balcones Research Center, 785 ft.
27 Mount Barker, 840 ft.
28 The Arboretum, 890 ft.
29 Mount Larson, 920 ft.
30 Cat Mountain, 925 ft.
31 Martin Hill, 931 ft.
32 Davis Hill, 940 ft.
33 Round Mountain, 968 ft.
34 Four Points, 1045 ft.
35 White Rim Mountain 1062 ft.
36 Jess Maynard Hill, 1137 ft.
37 Polecat Knob, 1145 ft.
38 Chalk Knob, 1202 ft.
39 Round Mountain, 1213 ft.
40 Bald Mountain, 1262 ft.
41 Travis Peak, 1270 ft.
42 Negrohead, 1330 ft.[c]

[a]lowest point in Travis County

[b]volcanic formation

[c]highest point in Travis County

Figure 4
GENERAL SOILS MAP
Travis County



1 Brackett
2 Tarrant
3 Speck-Tarrant
4 Houston Black-Heiden
5 Austin-Eddy
6 Burleson-Wilson
7 Ferris-Heiden
8 Bergstrom-Norwood
9 Travis-Chaney
10 Lewisville-Patrick

Source: Soil Conservation Service
Soil Survey of Travis County

Table 4
SOIL ASSOCIATIONS OF TRAVIS COUNTY

Mainly Shallow, Rolling, and Steep Soils of the Edwards Plateau

1 **Brackett Association**
Shallow, gravelly, calcareous, loamy soils overlying interbedded limestone and marl.

2 **Tarrant Association**
Very shallow, stony, calcareous, clayey soils intermingled with shallow soils overlying limestone.

3 **Speck-Tarrant Association**
Shallow, stony, loamy soils and very shallow, stony, clayey soils overlying limestone.

Mainly Deep, Gently Sloping Soils of the Blackland Prairie

4 **Houston Black-Heiden Association**
Deep, nearly level and gently sloping, calcareous, clayey soils overlying marl.

5 **Austin-Eddy Association**
Moderately deep and shallow, calcareous, clayey and loamy soils overlying chalk.

6 **Burleson-Wilson Association**
Deep, clayey and loamy soils overlying marl.

7 **Ferris-Heiden Association**
Deep, rolling and moderately steep, calcareous, clayey soils overlying marl.

Mainly Deep, Nearly Level and Gently Sloping Soils of Terraces and Floodplains Adjacent to the Colorado River

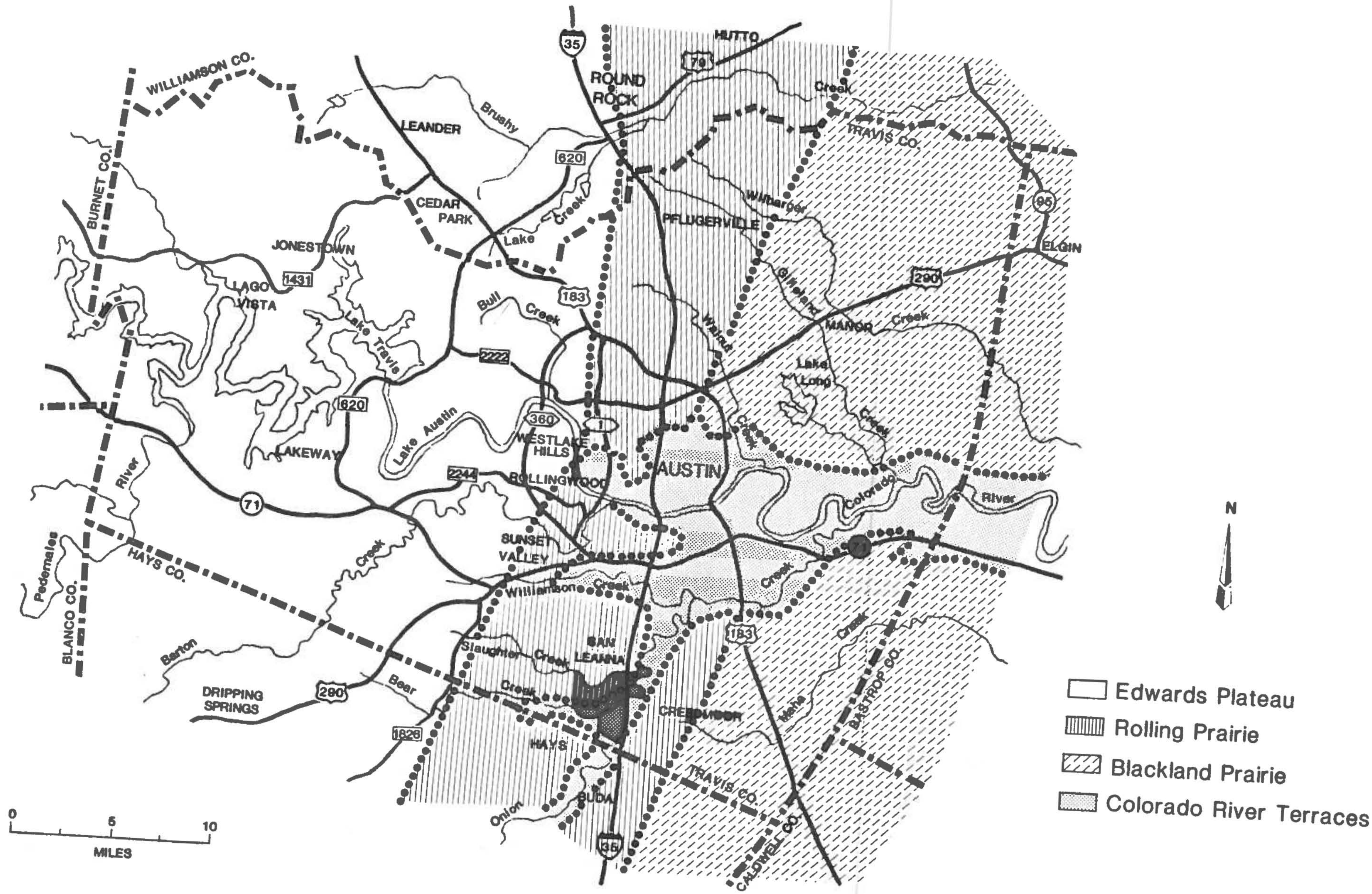
8 **Bergstrom-Norwood Association**
Deep, calcareous, loamy soils overlying recent and old alluvium.

9 **Travis-Chaney Association**
Deep, acidic, loamy soils overlying old alluvium.

10 **Lewisville-Patrick Association**
Deep and moderately deep, calcareous, clayey soils overlying old gravelly alluvium.

Source: U.S. Department of Agriculture
Soil Conservation Service
Soil Survey of Travis County, Texas, 1974

Figure 5
PHYSICAL GEOGRAPHIC REGIONS
OF THE AUSTIN AREA



southwestern Williamson County is, in local terms, a relatively large remnant of the Edwards Plateau. This virtually flat upland is only dissected by a few major streams. Around the perimeter of the Jollyville Plateau, drainageways have breeched the resistant limestone, carving out canyon heads.

There are some plateau areas of the Hill Country that are nearly level, but the topography of the Hill Country is generally rolling to steep, with some particulalry steep slopes occurring near the Colorado River and its tributaries. There are several peaks in western Travis County over 1200 feet, with Negrohead, at 1330 feet, being the highest elevation in the county (Figure 3).

The geology of this region is predominantly limestone, of the Edwards, Georgetown, Glen Rose, Comanche Peak, and Walnut Formations. Surface erosion of the Glen Rose has resulted in the typical "stair-step" topography of the Hill Country, in which alternating hard and soft rock beds are revealed.

Soils of the Hill Country are generally shallow and stony, and not conducive to agriculture. Some alluvial soils and clayey soils can be found along streams that dissect the landscape. In some places, the ground may be covered with a whitish crust, locally called caliche, that forms when groundwater is slowly brought up to the surface by capillary action and evaporates in the soil, leaving behind mineral salts, particularly calcium carbonate. In other places, the ground may be covered with a reddish clay known as terra rossa, that was formed by the oxidation of evaporites left behind in limestone after the shallow, warm-water sea that once covered the area subsided.

The land of the Hill Country has traditionally been used for ranching and grazing. Natural vegetation is dominated by Ashe juniper (locally called mountain cedar) and Spanish oak, with evergreen and flame-leaf sumac, agarita, mountain laurel, Texas redbud, red buckeye, yaupon, and yucca. On flat and rolling areas, savanna can be found, with thickets of live oak and scrub oak scattered in grassy areas.

2.2.2 Rolling Prairie

The Rolling Prairie begins directly east of the Balcones Escarpment. This region represents a transition between the Hill Country of the Edwards Plateau and the Blackland Prairie of the Gulf Coastal Plain. The topography is rolling, with many low hills. Slopes usually do not exceed 5 percent, and the terrain is moderately dissected by streams. The major part of the city is within this region.

The geology of the Rolling Prairie is predominantly chalk, of the Austin Group, with clays of the Del Rio and Eagle Ford Formations and hard limestone of the Buda Formation near the Balcones Escarpment. The soils are moderately deep to deep clays and clay loams. On the low chalk hills just east of the Balcones Escarpment, the natural vegetation consists of an abundance of live oak and juniper. Further east, the natural vegetation of the chalk prairie is characterized by broad stretches of tall grasses, with scattered live oak, mesquite, and juniper.

2.2.3 Blackland Prairie

The Blackland Prairie lies to the east of the Rolling Prairie. This region represents the western edge of the Gulf Coastal Plain. The topography is gently rolling, with slopes generally betwen 2 and 5 percent.

The geology of the Blackland Prairie is mainly clay, of the Navarro, Taylor, and Midway Groups. There is a small outcrop of basalt at Pilot Knob, an ancient volcano near Bergstrom AFB. There are also small outcrops of volcanic tuff at Pilot Knob and near Saint Edwards University. The soils of the Blackland Prairie are generally deep and clayey. Some of these soils have a high content of organic material, or humus, making them valuable to agriculture.

The natural vegetation of this region is primarily tall grasses with scattered mesquite and junipers, and some woodland areas of post oak, cedar elm, and eastern red cedar. But the area is now extensively farmed, and little natural vegetation remains.

2.2.4 Terraces and Floodplains of the Colorado River and its Tributaries

East of the Balcones Escarpment, the Colorado River crosses into the Gulf Coastal Plain. The river valley becomes much broader and the topography is gently rolling to nearly level. Relief in this region is largely associated with terraces formed during previous stages in the development of the river. The terraces of the Colorado River and its tributaries are composed of old alluvium, and the present floodplain of the river is covered with more recent alluvial deposits. Some alluvial deposits can also be found in the other physical geographic regions, where the Colorado River and its major tributaries dissect the terrain. Soils associated with alluvial deposits are generally deep and loamy.

The Colorado River Terraces contain a wealth of natural vegetation The higher, older alluvial terraces overlying the clay formations in the eastern part of this region are characterized by post oak, blackjack oak, cedar elm, eastern red cedar, and mesquite, with thick undergrowth of various shrubs. These woodlands represent the westernmost extension of the vast oak and hickory upland forests occurring east of the Austin area. In the lower, more recently deposited terraces and floodplains, the bottomland vegetative assemblage includes pecan, cedar elm, American elm, hackberry, green ash, box elder, and other trees, frequently with a dense understory of vines, shrubs, and sapling trees. Close to or on the stream banks are found bald cypress, black willow, cottonwood, and sycamore.

2.3 Native Animal Species

Native animal life is generally abundant in the Austin area because of the availability of water, forage, and ground cover. A great deal of diversity also characterizes local animal life, because of the distinct differences in physical geography across the Austin area.

2.3.1 Species Found throughout the Austin Area

Many native animal species can be found throughout the Austin area, fairly equally in all physical geographic regions. Most of these species will be more likely found away from human activity, but some, such as the raccoon, opossum, skunk, and grackle, are more tolerant of urbanization.

Common mammals include the Virginia opossum, Mexican free-tailed bat, nine-banded armadillo, eastern cottontail, black-tailed jack rabbbit, Mexican ground squirrel, fox squirrel, pocket mouse, white-footed mouse, gray fox, ringtail, raccoon, striped skunk, and white-tailed deer.

Common amphibians and reptiles include the cricket frog, gray treefrog, Texas toad, Stecker's chorus frog, Gulf Coast toad, bullfrog, common snapping turtle, red-eared pond slider, western box turtle, ground skink, broadbanded copperhead, western diamondback rattlesnake, Texas rat snake, eastern hognosed snake, and western ribbon snake.

Common resident birds include the bobwhite, killdeer, rock dove (domestic pigeon), mourning dove, Inca dove, starling, lark sparrow, house sparrow, eastern meadowlark, great-tailed grackle, red-winged blackbird, cardinal, brown-headed cowbird, mockingbird, common crow, Carolina wren, lesser goldfinch, red-bellied, woodpecker, and turkey vulture. The Austin area is also a haven for many species of migratory birds. Common migratory birds include the gadwall, ruddy duck, pied-billed grebe, northern shoveler, American coot, pintail, cedar waxwing, scissor-tailed flycatcher, white-crowned sparrow, vesper sparrow, chipping sparrow, horned lark, purple martin, and yellow-rumped warbler.

Common fishes include the longnose gar, carp, bluegill, white crappie, mosquitofish, smallmouth buffalo, river carpsucker, white bass, largemouth bass, channel catfish, yellow bullhead catfish, black bullhead catfish, and a variety of shiners, minnows, perches, and sunfishes.

Indigenous animal species are diverse and generally still abundant, which again reflects the contrast and richness of the physical environment of the Austin area.

2.3.2 Where East Meets West

Some native animal species are uncommon in parts of the Austin area, not because they are rare or endangered, but because they are on the margin of their geographical range. The Balcones Escarpment tends to act as a longitudinal boundary to many native animal species.

Some species found more in the western part of the Austin area because they are on the eastern edge of their geographical range include the scrub jay, black-crested titmouse, golden-fronted woodpecker, canyon wren, rock squirrel, plains harvest mouse, couch's spadefoot, green toad, tree lizard, short-lined skink, great earless lizard, Texas alligator lizard, Great Plains ground snake, and striped whipsnake.

Some species found more in the eastern part of the Austin area because they are on the western edge of their geographical range include the blue jay, red-bellied woodpecker, tufted titmouse, Carolina chickadee, field sparrow, ruby-throated hummingbird, fulvous harvest mouse, southern flying squirrel, green treefrog, eastern spadefoot, eastern box turtle, small-mouthed salamander, slender glass lizard, green anole (or "chameleon"), broad-banded water snake, and Texas long-nosed snake.

Since these species are already on the margin of their geographical range, continued urbanization may force them further to the east or west. Even though these species may be quite common elsewhere, it is desirable to maintain their presence locally, for our enjoyment and to conserve the integrity of the natural ecology of the area.

2.4 Surface Water Resources

Surface water resources are among the many natural amenities that make Austin a desirable place to live. The streams and lakes in the area supply us with drinking water, provide us sources of recreational and aesthetic enjoyment, and support a diversity of plants and animals.

2.4.1 Streams

Streams are generally associated with some of the best natural habitat in the area; a variety of animals are attracted to the water and abundant cover. Streams also provide another important function; they serve as natural drainageways for stormwater runoff.

Austin has a long history of recognizing the importance of its creeks. The City's first master plan, prepared in 1928, showed Waller Creek and Shoal Creek as greenbelts. In 1976, the City chose as its Bicentennial Project a program to "protect, preserve, and enhance creeks and waterways." Many of Austin's parks and greenbelts are located along its many creeks. Favorites include the greenbelts along Barton Creek and Bull Creek.

There are many streams in the Austin area (Figure 6), which contribute to two major river basins. In Travis and northern Hays Counties, streams flow into the Colorado River. In Williamson County, streams flow into the Brazos River.

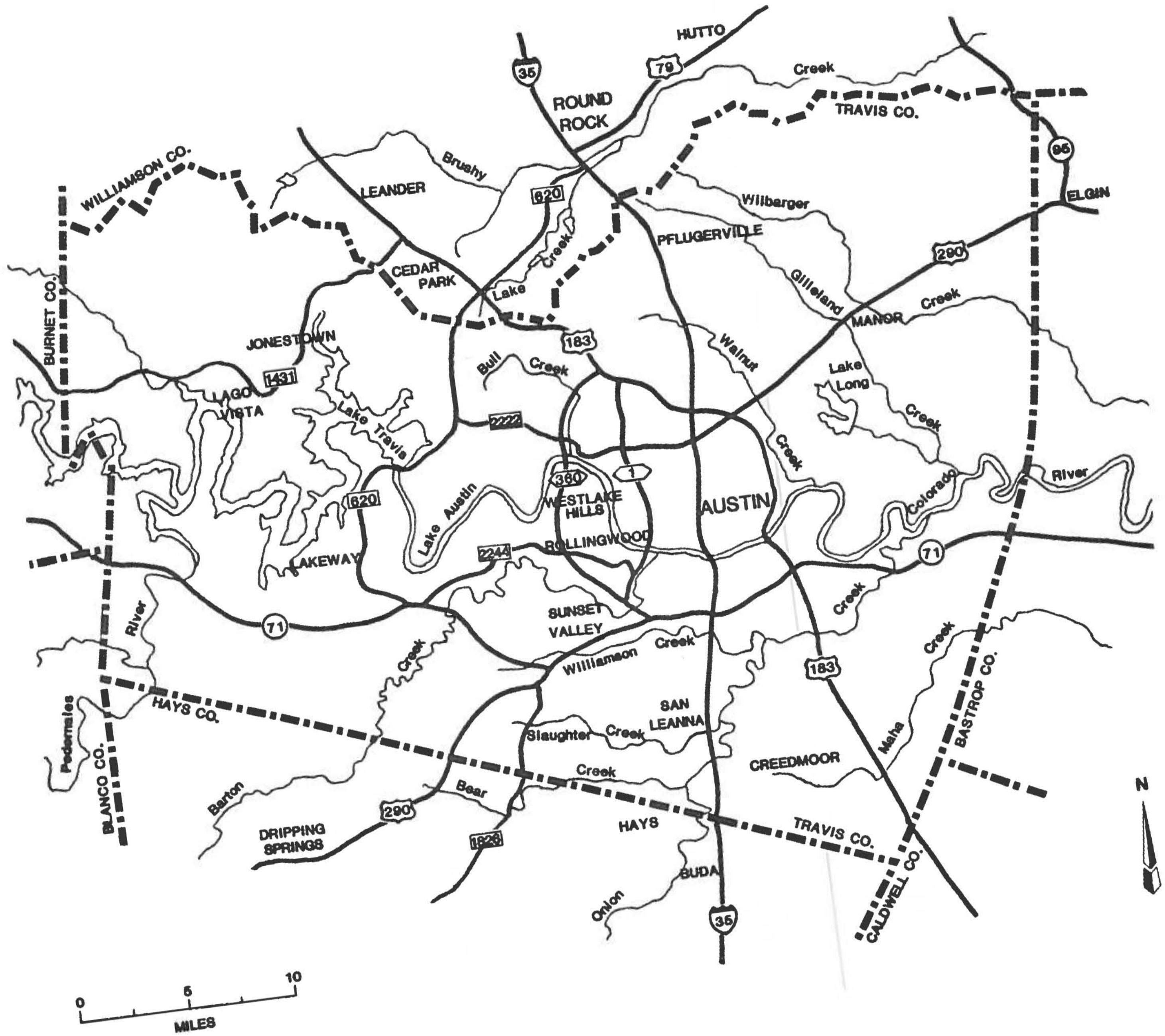
Several streams south of the Colorado River have large watersheds. The headwaters of these streams are in the more rural areas of the adjacent Hill Country in Travis and northern Hays Counties, and they cross the Balcones Escarpment into the Rolling Prairie as they flow toward the Colorado River. These streams include Barton, Williamson, Bear, Onion, and Slaughter Creeks.

North of the Colorado River, a few large streams cross the Jollyville Plateau. These streams, which flow east toward the Brazos River, include Rattan, Lake, and Brushy Creeks. Some major streams have their sources in canyons formed along the southern and western edges of the Jollyville Plateau. These streams, which flow toward Lake Travis and Lake Austin, include Bull, Cypress, and Lime Creeks.

In the Blackland Prairie in the eastern part of the Austin area, several major streams flow toward the Colorado River. These streams include Walnut, Gilleland, Wilbarger, and Cottonwood Creeks, which flow south to the Colorado River, and Maha and Dry Creeks, which flow north to the Colorado River.

Austin has several urban creeks that provide some attractive greenbelt areas running through the city, and offer the potential for more recreational and aesthetic utilization. Among these creeks are Shoal and Waller Creeks, which flow south to Town Lake, and Blunn, Bouldin, and Country Club Creeks, which flow north to Town Lake.

Figure 6
MAJOR STREAMS AND LAKES
IN THE AUSTIN AREA

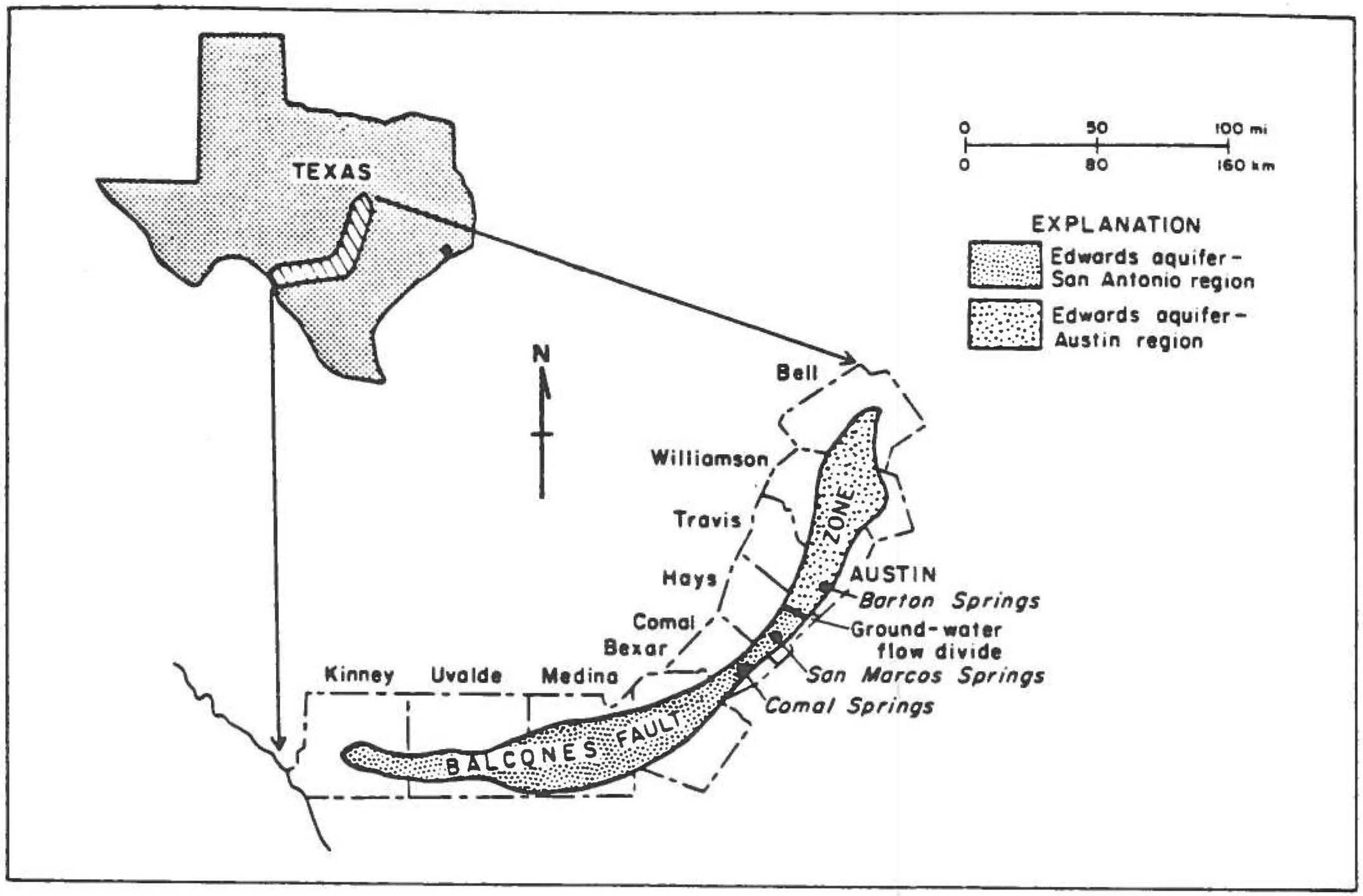


2.4.2 Lakes

There are several lakes in the Austin area (Figure 6). The Colorado River has been impounded at different points to form a series of reservoirs called the Highland Lakes. Lake Travis, formed by Mansfield Dam, is west of Austin and is the largest lake in the area around Austin. The scenic drives around Lake Travis offer many panoramas of the Texas Hill Country, attracting people from all over the state. Below Lake Travis is Lake Austin, formed by Tom Miller Dam. One of Austin's most popular locations, Emma Long Metropolitan Park, is located on Lake Austin. Below Lake Austin is Town Lake, formed by Longhorn Dam. Town Lake, with its extensive hike-and-bike trail, is an attractive urban greenbelt running through the heart of Austin. Although these lakes are man-made features, they add to the natural beauty of the area and create important habitat. They also offer us a number of recreational opportunities and provide us with drinking water.

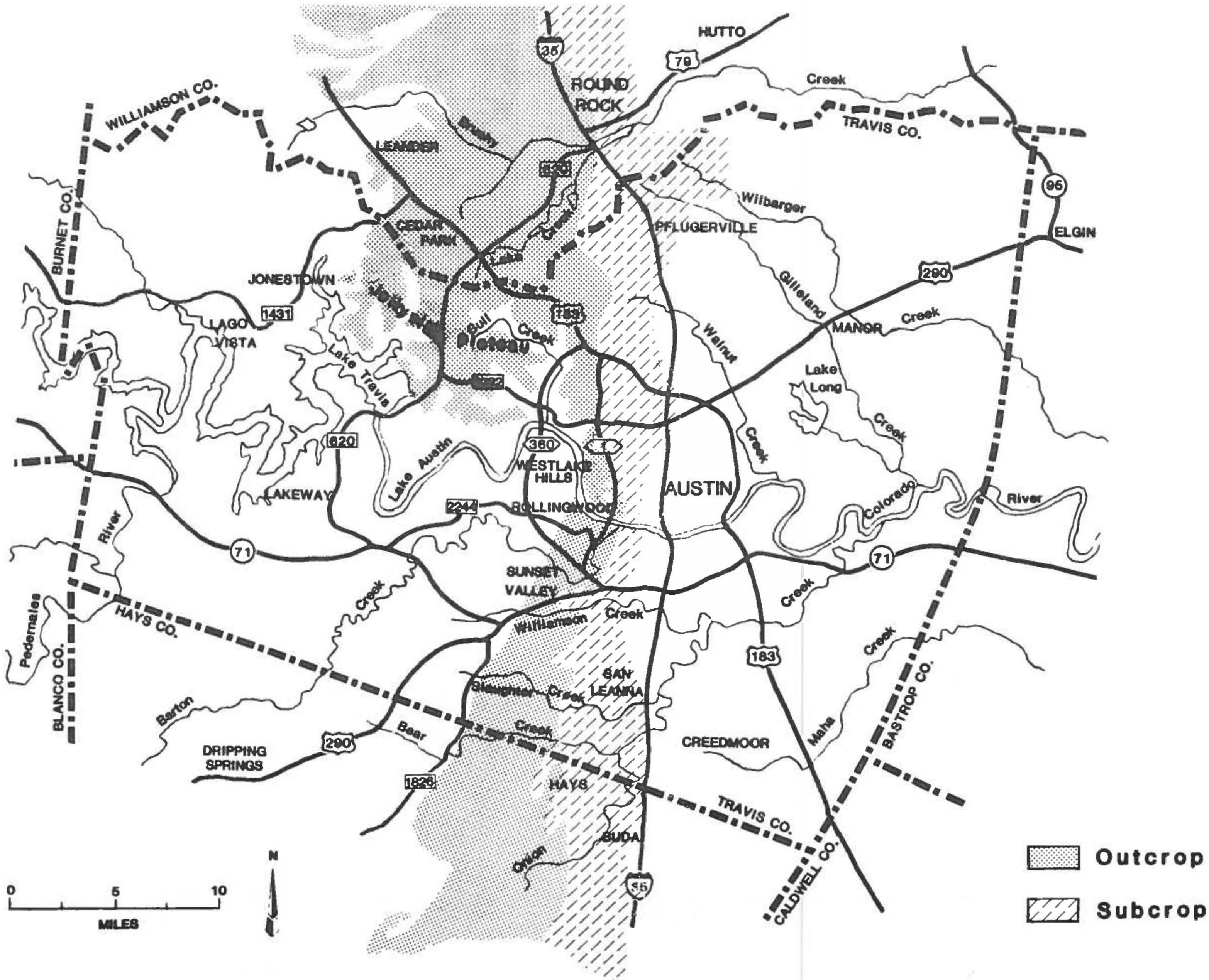
Lake Long, in the Blackland Prairie east of Austin, is formed by a dam on Decker Creek. Lake Long not only serves as a cooling reservoir for Decker Power Plant, it provides people in the Austin area with even more recreational opportunities. Some of the grasslands and heavily wooded areas around Lake Long are of nature preserve quality, and some significant wetland habitat has developed along parts of the shoreline.

Figure 7
THE EDWARDS AQUIFER IN TEXAS



Source: Texas Dept. of Water Resources, 1978

Figure 8
THE EDWARDS AQUIFER IN THE AUSTIN AREA
Outcrop and Subcrop



As a discrete hydrogeological unit, the southern Edwards Aquifer has certain boundaries. The "bad-water" line (where groundwater contains more than 1000 mg/l total suspended solids) represents the eastern boundary of the aquifer, and the Mount Bonnell Fault delineates the western boundary. The northern boundary is delineated by the Colorado River, and the southern boundary is a non-structural groundwater divide, determined by an equilibrium in groundwater pressure. This divide roughly coincides with the surface drainage divide between Onion Creek and the Blanco River. The relatively impermeable Walnut Formation is the lower confining layer of the aquifer, and where the aquifer dips into the subsurface, the Del Rio Clay is the upper confining layer.

In the outcrop zone, the Edwards is exposed at the surface and has no upper confining layer; it is considered a water table aquifer. But in locations where the aquifer is overlain by other formations, the aquifer is under pressure, and artesian conditions exist. The height of the water table is largely influenced by rainfall trends, and to a lesser extent by pumpage.

The main point of natural discharge of the aquifer is at Barton Springs, located about a half-mile upstream from the mouth of Barton Creek. The average rate of discharge at Barton Springs is about 50 cubic feet per second (cfs), or about 32 million gallons per day (MGD).

2.5.2 Northern Edwards Aquifer

Until recently, this segment of the aquifer has not received a great deal of attention compared to the Barton Springs segment. But now that a growing number of people in Williamson County are becoming dependent on groundwater, and because a number of sensitive environmental features have been identified in the area, the northern Edwards is receiving more attention and study.

The northern Edwards extends from the Colorado River and progressively thins to the north through Williamson County until it ultimately pinches out in Bell County (Figure 8). The northern Edwards covers a larger area than the southern Edwards. The recharge zone of the northern Edwards covers an area of approximately 400 square miles.

In many locations, particularly the southern and western perimeters, the thickness of the aquifer outcrop has been substantially diminished by faulting and erosion. In these areas, the groundwater yield is low and may be seasonally undependable. The aquifer thickens considerably to the east, and groundwater yields are much higher and more dependable. The full thickness of the aquifer is found in the artesian section, to the east of the Balcones Fault Zone.

An interesting feature of the northern Edwards is the Jollyville Plateau. It is a classic karst upland, in that surface erosion is associated primarily with the dissolution of limestone rather than with runoff and stream dissection. The relatively flat terrain is pitted with sinkholes, indicating the presence of collapsed caverns beneath the surface. Along the edges of the Jollyville Plateau, drainageways have incised canyons, in which seeps and springs issuing from the exposed water table aquifer give rise to a number of streams. These canyon heads support a great diversity of plant and animal life, and have a high potential for harboring some locally uncommon species.

Recharge to the northern Edwards occurs in stream beds, but not to the extent that it does in the southern Edwards, where streams lose up to 100 percent of their base flows to the aquifer. Only a few major streams cross the northern Edwards: Berry Creek, Brushy Creek, Lake Creek, the North and South Forks of the San Gabriel River, and Salado Creek. Some stream segments show partial loss of base flow to the aquifer, but some stream segments show a net gain in base flow because of the contribution of springs. Most of the recharge through stream beds occurs toward the eastern part of the region, where these streams cross major fractures in the Balcones Fault Zone.

Unlike the southern Edwards Aquifer, the northern Edwards does not have a single major discharge point. Many small springs are located along streams that cross the aquifer. Several major springs are located along the Balcones Fault Zone, including Georgetown Springs, Salado Springs, and Berry Springs. Another significant spring is Powerhouse Springs near Tom Miller Dam on the northern bank of the Colorado River. Numerous small springs issue from the northern Edwards along the broken perimeter of the Jollyville Plateau, in the watersheds of Lake Travis and Lake Austin. Many artesian springs exist east of the Balcones Fault Zone where the aquifer dips into the subsurface; some of these springs have reportedly never gone dry.

2.5.3 Other Groundwater Resources

The Edwards Aquifer has received a great deal of recent attention because of the concentrated growth occurring in its recharge zone, and because a large portion of the aquifer is associated with Barton Springs, an immensely popular Austin attraction. But the Edwards is by no means the only aquifer in the Austin area.

Underlying the Edwards Aquifer is the Trinity Group Aquifer, contained in the Glen Rose and Travis Peak Formations. In the western part of the Austin area, many people depend on Trinity groundwater. Even in areas overlain by the Edwards Aquifer, some people drill deep wells into the Trinity, because the Edwards outcrop may be too thin to provide a reliable water supply. The recharge zones of the aquifers underlying the Edwards are located to the west of the Austin area.

The Alluvium and Terrace Deposit Aquifer still provides a large portion of the total water supply in the area east of Austin. This aquifer is composed primarily of sand and gravel, and is associated with the floodplains and terrace deposits of the Colorado River and its major tributaries.

2.6 Natural Constraints to Development

Some natural features in the Austin area, such as floodplains, expansive soils, and unstable slopes, may present constraints to development in the Austin area. Because of their inherent physical properties, these features may require some special engineering and architectural considerations.

2.6.1 Floodplains

The chances for a storm of large magnitude, such as a hundred-year flood event, are not that remote in the Austin area. Because of the relatively high potential for intense rainfall events, and aggressive stream dissection creating hilly, often steep, topography, streams in the Austin area are naturally susceptible to flooding. The effects of urbanization tend to exacerbate this problem; namely the increases in runoff that are generally associated with additions of impervious surfaces. Figure 9 shows that a hundred-year flood event would occur in the Austin area if we were to receive rainfall at a rate of 1.5 inches per hour over a period of six consecutive hours.

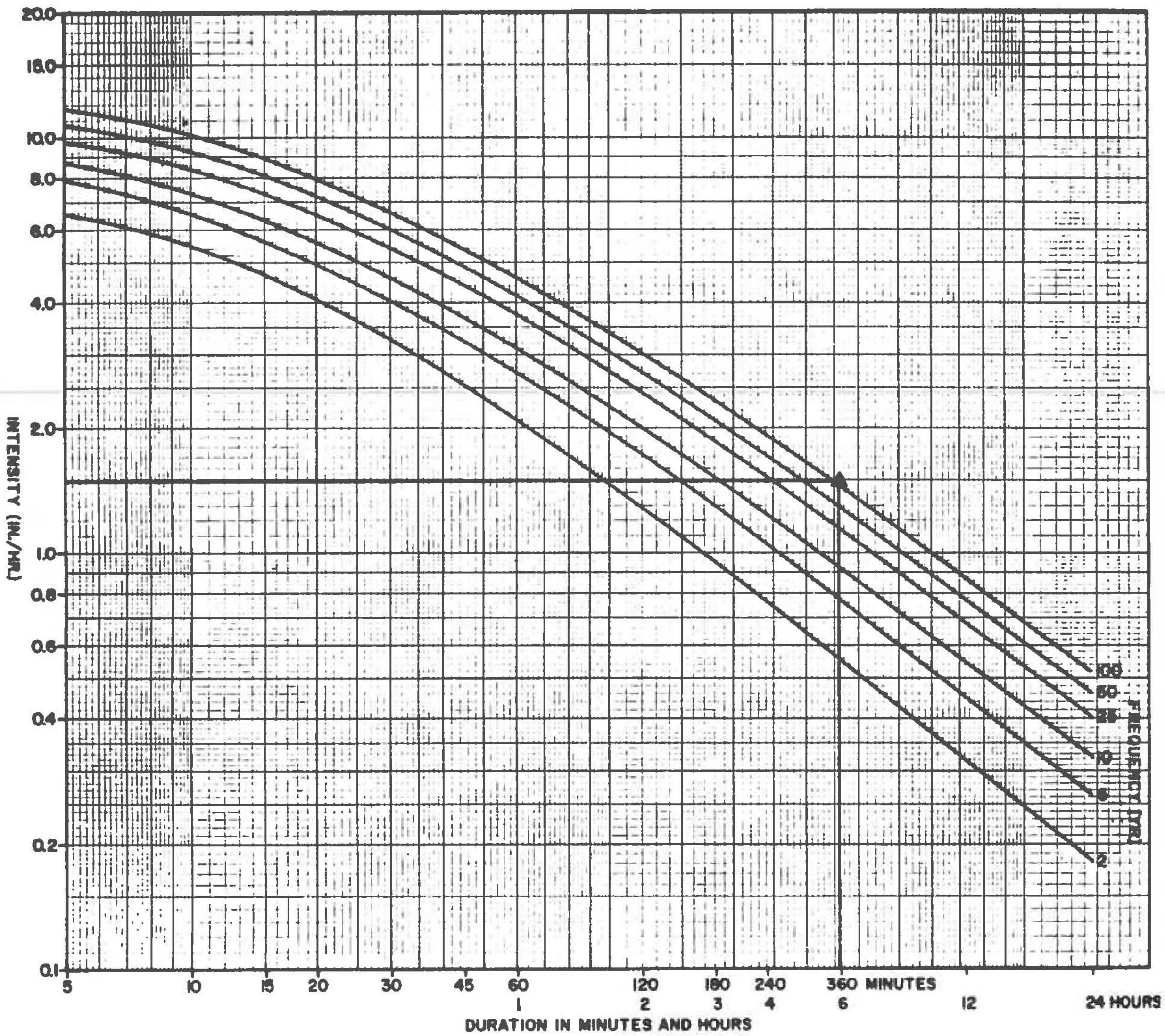
A floodplain is the area that may be partially or totally inundated when a stream overflows its banks during a storm. The attraction to building in a floodplain can be great, because of the level land, conducive soils, and aesthetically pleasing surroundings. The obvious natural constraint to development in floodplains is flooding. Those who choose to build or live in a floodplain must accept some inherent risks. Even with extensive flood controls, developed areas in a floodplain can be susceptible to flood damage caused by a storm of large magnitude.

2.6.2 Expansive Soils

Expansive soils are generally classified as vertisols, and are found frequently in the eastern part of the Austin area. Expansive soils, such as the Houston Black series, generally have a high content of fine clay, called montmorillonite, that shrinks and swells with changes in moisture. When these soils dry out they contract, often leaving wide cracks in the ground. Sediment may accumulate in these cracks, and as the soil moisture content increases, the soil mass expands. Eventually, as the soils swell, the cracks close up over the accumulated sediment, developing small mounds in an otherwise flat terrain. This micro-relief pattern is referred to as gilgai.

Soil movement in expansive soils can cause sidewalks, streets, slab foundations, and underground pipes to buckle or crack. Expansive soils generally have a high plasticity, meaning that they continually deform under stress. Their capability to support a structural load without deforming is limited, so expansive soils generally have low bearing strengths. Special, more expensive engineering designs are usually required for building on expansive clay soils.

Figure 9
RAINFALL CURVES FOR THE AUSTIN AREA



▲Rainfall curves for the Austin area indicate that if it were to rain for 6 consecutive hours, at a rate of 1.5 inches per hour, we would experience a 100-year flood event.

Source: City of Austin, 1977
Drainage Criteria Manual

2.6.3 Unstable Slopes

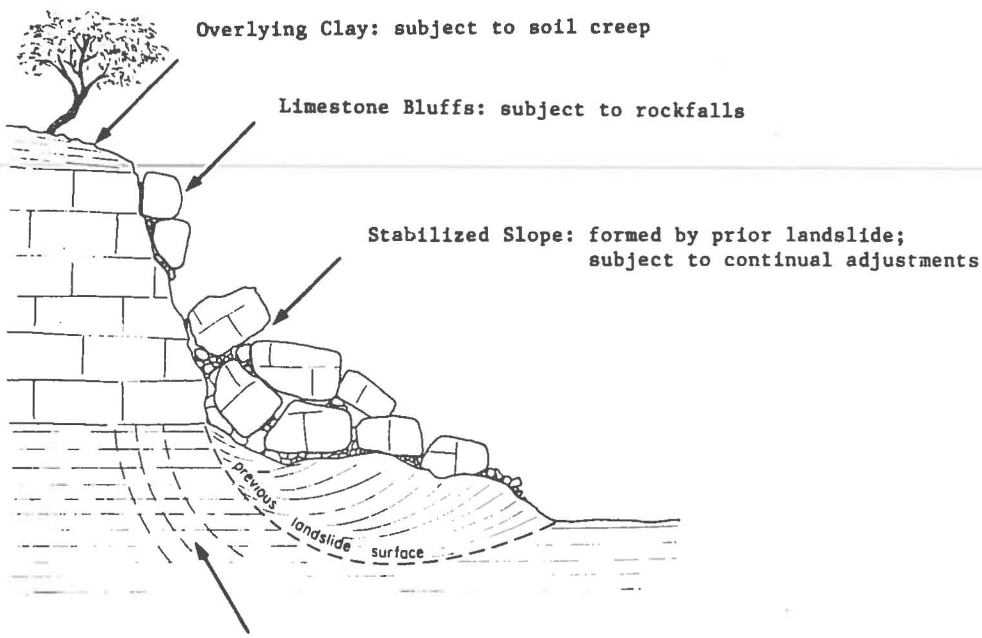
A slope is unstable if the slope material has a considerable potential for movement. A slope is not inherently unstable just because it is steep; for example, a large outcrop of bare limestone that is not underlain by a plastic soil is generally stable. Slopes that are covered with loosely consolidated material, such as sandy soils and loose rock (tallus) are highly erodible and are particularly unstable. The ground under foundations and piers can give way. Without proper erosion controls, cutting into slopes and the removal of vegetative cover can accelerate slope erosion.

The natural gravitational movement of soils downslope is called soil creep; plastic soils particularly display this phenomenon (Figure 10). Soil creep is a gradual movement, but over time it can cause serious structural damage.

If stress is applied to expansive soils on a slope, shearing may result. Shearing is the movement of one soil mass against another, parallel to the plane of contact. Parallel striations in the soil, called slickensides, are evidence of shearing. Under sufficient stress, an unstable slope may fail. A slope failure is the massive movement of material downslope, generally called a landslide or a slump.

Unstable slopes may occur virtually anywhere in the Austin area, but particulalry in places where plastic soils overlie slopes. Some of the most unstable slopes in the area occur in places where Buda Limestone overlies Del Rio Clay. When the clay bases that have naturally stabilized over time have been disturbed by construction activity, the clay then tends to exude, making the overlying limestone subject to movement (Figure 10).

Figure 10
SLOPE INSTABILITY



Source: Bureau of Economic Geology, 1979
Land Resource Overview of the CAPCO Region

3.0 ENVIRONMENTAL ASSESSMENT

The natural environment of the Austin area is still of relatively high quality. But as the population of the Austin area continues to grow at a substantial rate, the natural environment becomes more exposed to the activities of man. Some natural resources are not as tolerant to disturbance as others. This section provides an assessment of the impacts of urbanization on the environment and discusses the state of some important natural resources.

Wild Onion
Allium canadense var. *mobilense*

Source: Grimmer & Laughlin, 1982
ABC's of Texas Wildflowers

3.1 Air Quality

By comparison to other Texas cities, Austin's air quality is still relatively good, but most air quality specialists agree that air quality in the Austin area is generally deteriorating in association with urbanization, and air pollution seems to be a growing public concern.

At the present time, the major source of air pollution in the Austin area is suspected to be road vehicle emissions. Table 5 indicates a steady increase in the number of vehicle registrations in the Austin area, which implies an increase in the number of vehicles on the road. Another major category of air pollution in the Austin area is referred to as area emissions, which may equal or exceed road vehicle emissions. Area emissions include numerous, relatively small sources scattered throughout the Austin area that produce emissions as a byproduct of the activity that occurs at the site. For example, gas stations, printers, dry cleaners, and automobile repaint shops all produce evaporative emissions. Other sources of air pollution in the Austin area include some large industries, electric power plants, construction activity, open burning, landfills, and mobile sources other than road vehicles, such as aircraft, trains, and motorboats.

Local concentrations of sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead are generally low, and are well within National Ambient Air Quality Standards. Although Austin has no history of non-compliance for total suspended particulates (TSP), values for this pollution parameter are frequently high. TSP can cause eye and respiratory irritation, and some particulates in vehicle emissions are suspected carcinogens. Vehicle emissions can contribute a significant amount of particulate matter to the air. Diesel engines that are only slightly out of tune can emit a relatively large amount of particulate matter. Construction activity can increase the amount of dust in the air, especially during dry periods; open burning can also contribute to TSP values. A variable amount of natural material, such as pollen, may be present in air samples, and this material is included in TSP values. Dust storms, which occur once or twice a year in Austin, are natural events that can greatly impact TSP values. Air quality data collected during dust storm events that are acknowledged by the National Weather Service are excluded for purposes of determining compliance.

Ozone levels in the Austin area are sometimes a problem. In the upper atmosphere, ozone serves a useful purpose, in that it reduces the amount of ultra-violet radiation that reaches the earth's surface. But ozone can be a serious air pollutant when it forms in the lower atmosphere, causing eye and respiratory irritation. Ozone is formed when certain air pollutants (i.e., nitrogen dioxide and hydrocarbons) are acted on by sunlight. Ozone levels usually peak in the afternoon hours. High ozone levels tend to be most prevalent in the summer, when we experience more intense solar radiation and longer periods of daylight. Ozone is the only air pollution parameter with which Austin has had compliance problems. In 1981, Austin recorded one exceedance of the ozone standard, and in 1980 and 1985, two exceedances. As indicated in Table 6, this is a small number of exceedances in comparison to other Texas cities. In 1982 through 1984, Austin recored no ozone exceedances, and none in 1986; therefore, no discernible trend is readily

Table 5
VEHICLE REGISTRATIONS IN THE AUSTIN AREA

Year	Travis County	Williamson County	Hays County
1979	307,123	57,271	25,394
1980	316,028	64,585	28,481
1981	352,065	66,292	30,213
1982	368,500	70,564	31,221
1983	369,438	75,957	35,003
1984	438,612	85,833	39,135
1985	467,398	94,535	44,149

Source: City of Austin
Department of Planning and Growth Management

Table 6
HISTORY OF VIOLATIONS OF NATIONAL OZONE STANDARD+
For Selected Texas Cities from 1980 to 1985

City	Number of Days over Standard by Year 1980	1981	1982	1983	1984	1985
Aldine	10	23	8	22	19	16
Austin	2	1	0	0	0	2
Beaumont	2	2	5	6*	10	0
Clute	1*	4	4*	4	3	0
Corpus Christi	3	1	1	0	1	0
Dallas	10	6	11	7	7	3
Denton	--	9	2	16	7	10
El Paso	7	1	2	3	8*	8
Fort Worth	4	4	5	1	9	5
Houston	28	28	25	33	15	21
Longview	2	1	2	4	1	1
San Antonio	0	1	2	1	1	0
Seabrook	16	20	16	16	10	17
Texas City	14	0*	13	2*	5	8

+The National Ambient Air Quality Standard (NAAQS) for ozone is 0.12 parts per million (ppm).

*Indicates less than a 50% data return for the ozone season (April through September).

Source: Texas Air Control Board

evident. However, the fact that Austin experienced no exceedances of the ozone standard in 1986 came as a pleasant surprise to most air quality specialists. If the ozone standard is ever exceeded more than once a year on the average for three consecutive years, Austin could be subject to review by the Texas Air Control Board and required to develop a pollution control and abatement strategy.

In some parts of East Texas and along the Gulf Coast, acidic rain is becoming more prevalent, but it is not a problem in the Austin area at this time. Rainfall is naturally slightly acidic, because cloud droplets can combine with atmospheric carbon dioxide to form a weak carbonic acid. But the acidity of rainfall can be significantly increased due to the presence of air pollutants, such as sulfur dioxide and nitrogen oxides. The average acidity of rain in the Austin area has increased in the past decade, but our natural waters and soils are not directly threatened, since the dominant calcareous geology of the area provides them with a generally high buffering capacity. Also, no adverse effects on local flora or fauna have been detected.

Because we spend so much time in our homes, in our workplaces, and in public places, indoor air pollution is also a growing concern. Sources of indoor air pollution include tobacco smoke, spray paint and lacquers, asbestos particles, pesticides, wood preservatives, hot water heaters, and space heaters. Radon may be emitted from granites and certain uraniferous shales, but radon is not generally considered a problem in the Austin area because of the dominant calcareous geology. Just as ambient air pollution can cause health problems, indoor air pollution can cause eye and respiratory irritation, and lead to other sicknesses, even cancer.

3.2 Noise

Noise can be both aesthetically displeasing and physically harmful, and as such, it must be considered a form of environmental pollution. Traditionally, noise controls and regulations are based on nuisance and disturbance of the peace. However, in more recent years, noise regulations have considered the public health aspects of noise. Various scientific studies indicate that there can be negative effects of ambient noise on physical and mental health. As indicated in Table 7, sustained exposure to noise levels over 85 decibels can result in impairment of hearing, stress and heart disease, loss of sleep and fatigue, danger to the unborn, and danger to life when auditory warning signals are obscured. Sustained exposure to noise can also cause structural damage to buildings.

Vehicular traffic, which is the major source of air pollution, is also the major source of noise pollution. Driving in heavy traffic is not the only way in which people are subjected to traffic noise; many homes and businesses are located along or near heavy traffic corridors.

Noise from aviation activities is an important concern to many people. Since the areas most affected by noise from the municipal airport are already built up, it is too late to develop a compatible land use plan; however, land use controls can be imposed on new development and redevelopment. A possible, though controversial, solution to aircraft noise from Mueller may be moving the municipal airport to an outlying location. Aircraft operations are likely to continue at Bergstrom Air Force Base for the indefinite future. There is still opportunity to impose some land use controls around Bergstrom, as the area is not completely developed.

Other sources of noise pollution include construction activity, certain industries, railroads, and electric powerplants and substations. Noise in the workplaces or in the home is not only a nuisance, it poses an often overlooked safety and health hazard.

According to the Austin Tomorrow Comprehensive Plan of 1980, noise was ranked seventh out of fifteen environmental problems listed by citizens. But as the Austin area continues to grow, noise from vehicle traffic, air traffic, and construction activity will likely increase, and noise will probably be perceived as a more serious environmental problem.

Table 7
NOISE LEVELS

Noise levels are measured in units called decibels (db). The following decibel scale represents ratios of sound intensities to the threshold of hearing. It is a logarithmic scale, so the difference in sound intensity between the threshold of hearing and 60 db is a million times as much; the difference between 60 db and 80 db is a hundred times as much.

Noise Source	Decibel Level	Ratio of Sound Intensity to Threshold of Hearing
Threshold of hearing	0	10
Normal breathing	10	10
Rustle of leaves	20	10
Soft whisper	30	10
Refrigerator	40	10
Typewriter	50	10
Conversational speech	60	10
Passing automobile	70	10
Alarm clock, vacuum cleaner, garbage disposal	80	10
Power lawn mower	90*	10
Passing truck, auto horn	100	10
Thunder, sonic boom	110	10
Amplified rock music, threshold of pain	120	10
Air raid siren	130	10
Jet plane at takeoff	140	10

*Sustained exposure to greater than 85 db may result in damage to health.

3.3 Solid and Hazardous Waste Disposal

As the Austin area continues to grow, so will the amount of solid and hazardous wastes generated by the population and industries. Proper disposal of wastes is important for public health, environmental protection, and aesthetic reasons.

Most of our domestic waste is landfilled. As shown in Table 8, the amount of material landfilled in the Austin area has increased steadily over the last few years. An important environmental concern is that a significant amount of liquids-- such as paint, motor oil, antifreeze, insecticides, acids, and solvents--are contained in the waste disposed of in landfills. When these liquids are placed in landfills, they may leak into the surrounding environment, possibly contaminating surface water or groundwater resources.

Since it may not be permissable to dispose of certain domestic wastes in the sanitary sewer or in the stormsewer, consumers may be left with few alternatives to disposing of these materials in the trash can. Some voluntary measures that consumers may take to mitigate this problem include:

- buy products that are biodegradable or less toxic
- look for multi-purpose products to avoid accumulation of single-purpose products that may not be fully used
- buy only in quantities that are actually needed to do the job
- before disposing of the product, see if anyone else can use it or if it can be recycled
- if the product can be safely stored, save it for a special collection day for household chemicals

There are currently three landfills in the Austin area open to the public. The City of Austin operates a municipal landfill east of Pilot Knob, on Elroy Road. There are two privately owned landfills located next to each other between Austin and Manor, on Highway 290. There are also two County transfer stations open to the public in western Travis County. Waste brought to these sites is relayed to the municipal landfill. Garbage collected by City sanitation crews is taken either to the municipal landfill or to the two private landfills.

At one time or another, 36 landfills have been operative in Travis County (Figure 11), some of which were not legally operated. Of these landfills, nine have been found to contain hazardous industrial wastes, and seven have a potential for containing hazardous industrial wastes. Hazardous industrial wastes have been removed from some sites, but leakage of remaining hazardous industrial wastes from closed landfills is an important concern. Several of these sites are monitored routinely for leakage. Another 30 smaller sites in

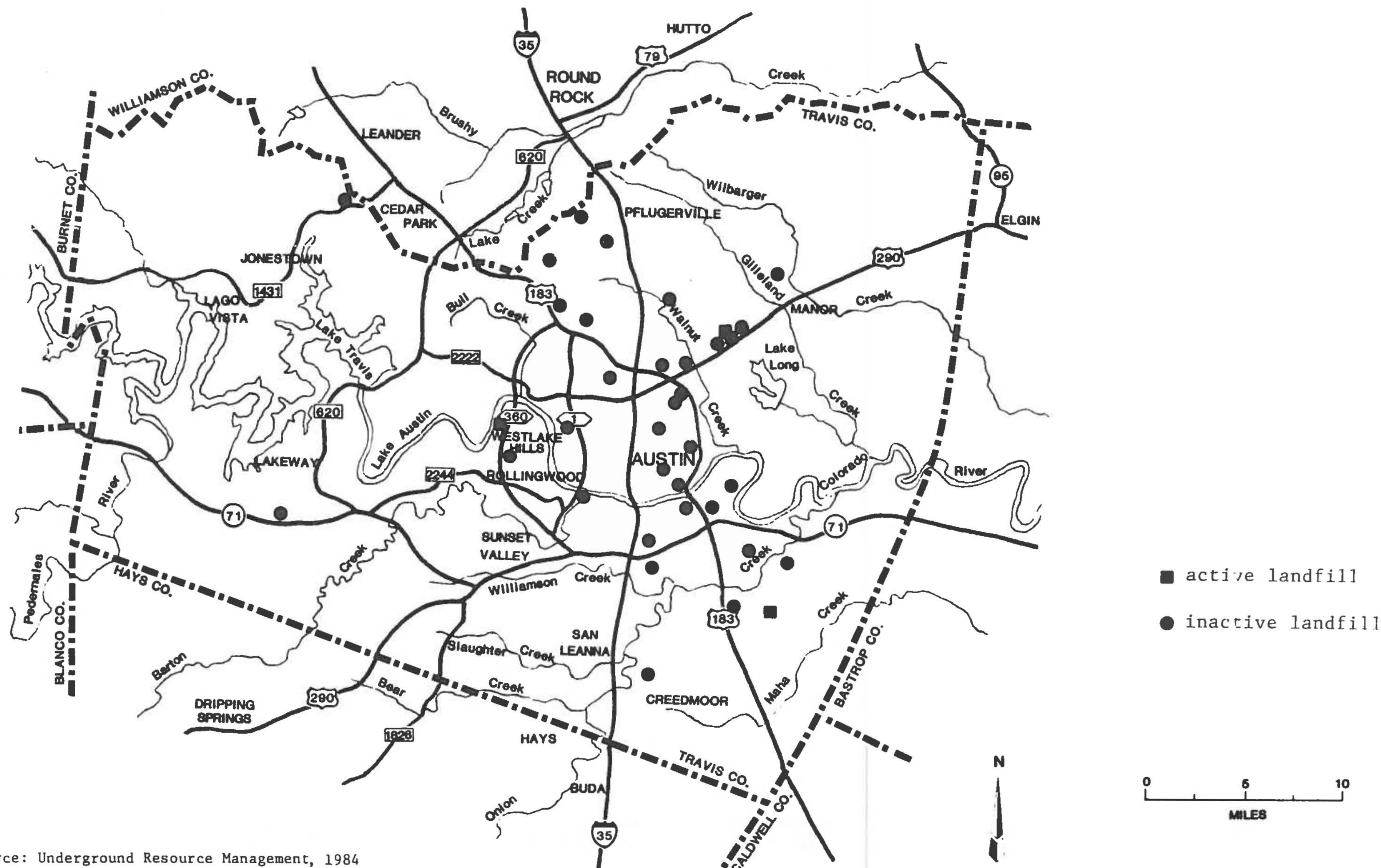
Table 8
AMOUNTS OF REFUSE LANDFILLED IN THE AUSTIN AREA

The following table gives data for the amount of refuse landfilled by the City of Austin, Department of Public Works, Solid Waste Services (SWS) Division. SWS disposes of most of the refuse it collects at the municipal landfill on Elroy Road, and the remained at two private landfills located on Highway 290 between Austin and Manor. Data is also given for amounts of refuse brought by the general public to the municipal landfill.

Year	Muni Fill by SWS (tons)	Muni Fill by others (tons)	Private Fills by SWS (tons)	Totals (tons)
1981	79,241	42,187	70,065	191,493
1982	111,996	55,387	46,035	213,418
1983	123,736	46,935	45,224	215,895
1984	131,628	63,595	53,159	248,382
1985	141,933	75,922	44,076	261,931
1986 (through June)	81,328	69,279	30,296	180,903

Source: City of Austin
Transportation and Public Services Department

Figure 11
LANDFILLS IN TRAVIS COUNTY



Source: Underground Resource Management, 1984
Landfills in the Vicinity of Austin, Texas

Travis County have been used at one time or another for legal or illegal dumps, but these sites show no evidence of containing hazardous industrial wastes.

Generators of hazardous industrial wastes are now subject to much more stringent procedures for disposal of those wastes; federal, state, and local regulations have become quite specific. In some cases, certain hazardous industrial wastes may be acceptable to the sanitary sewer or the storm sewer, but only after they have been filtered, pre-treated, or neutralized, and this type of disposal is carefully regulated and monitored to prevent contamination of water resources. Certified waste management companies can be contracted to dispose of hazardous industrial wastes in licensed incinerators or in landfills licensed to accept certain types of hazardous wastes. Occasionally, though, some illegal dumping of hazardous industrial wastes still occurs in creeks or along remote roads.

3.4 Surface Water Resources

Our surface water resources are too important to be taken for granted. We depend on surface water for our municipal water supply and for recreation, and surface water resources support a wide variety of plant and animal life. These resources are invaluable, but they are vulnerable to degradation from a number of sources.

Stormwater runoff from urban and agricultural areas is the primary source of water pollution. Stormwater runoff can contain grease and oil, fertilizers, herbicides and pesticides, heavy metals, and animal wastes. But in many cases, the major pollutant in stormwater runoff is sediment. Erosion and the subsequent deposition of sediment carried by stormwater runoff can have several significant environmental and economic impacts:

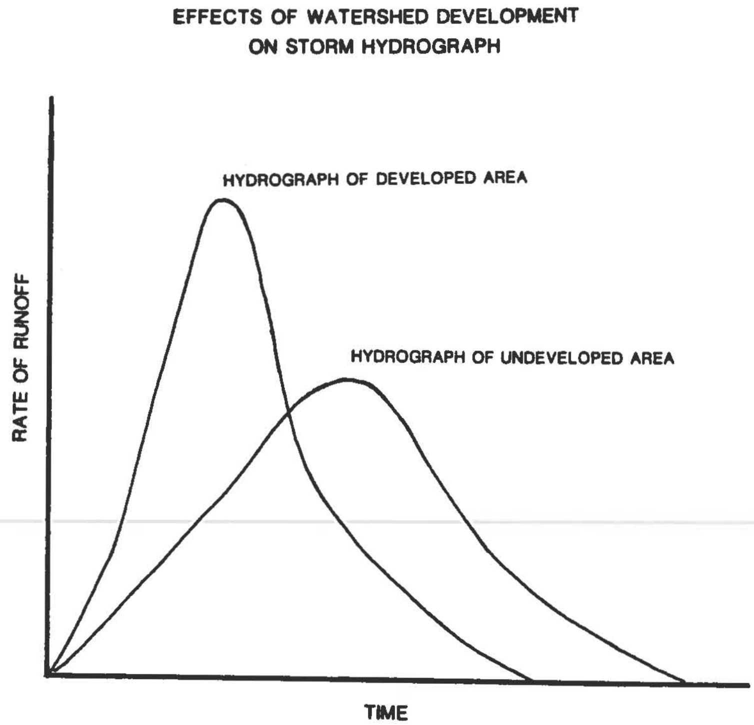
- costly removal of sediment from culverts, stream channels, and drainageways
- disturbance to aquatic ecosystems
- alterion of stream flow patterns, which can result in bank erosion or flooding
- transport of pollutants that adhere to sediment particles
- limiting recreational uses of receiving streams
- increasing overall costs of potable water treatment

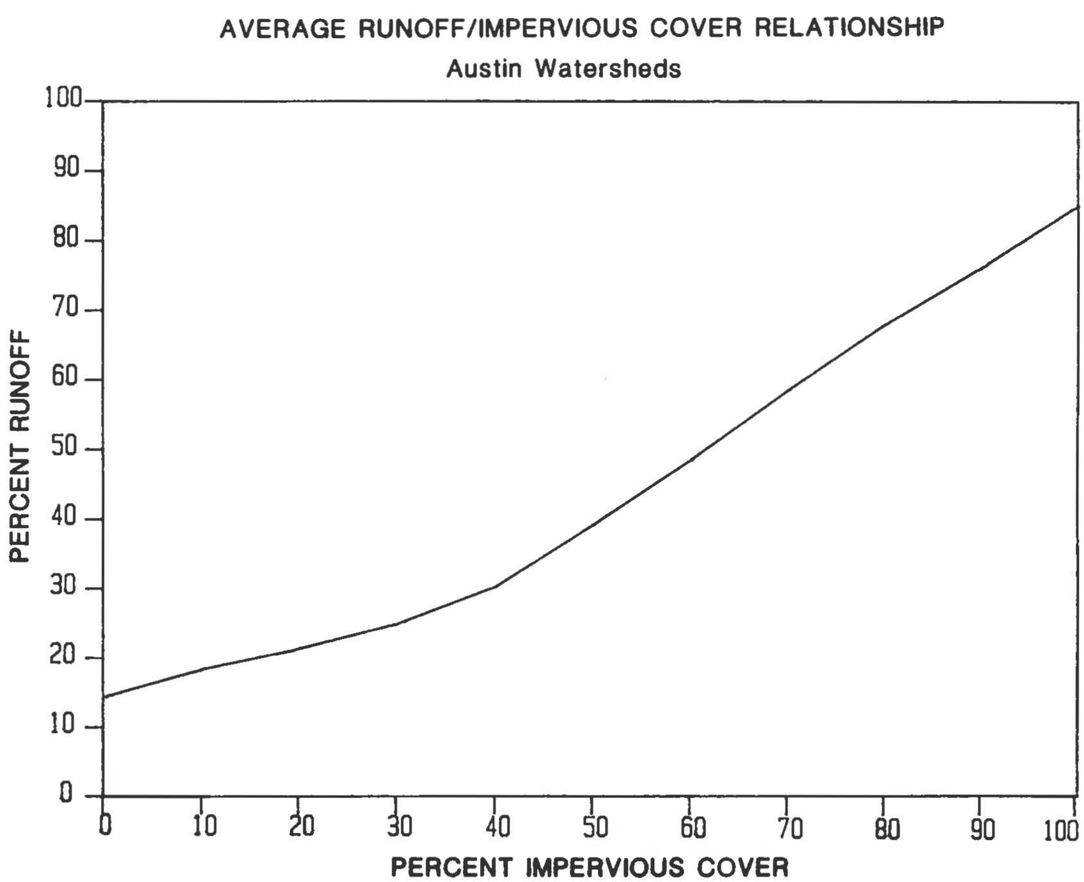
Urbanization usually results in the addition of impervious cover--types of surfaces such as pavement and buildings that do not allow water to percolate into the ground. Additions of impervious cover correspond to increases in the volume and velocity of stormwater runoff. This not only increases the potential for water pollution, it causes streamflows to peak sooner and higher after storm events, increasing the potential for flooding and stream bank erosion (Figure 12).

Stormwater runoff is considered a non-point source of water pollution, since many different sites can contribute to the runoff that reaches a stream. A point source of water pollution originates from a specific site, such as a sewage treatment plant.

There are several sewage treatment plants permitted or proposed in Travis County, as shown in Figure 13. Currently, 37 treatment plants in Travis County are permitted to dicharge a total of 121.78 million gallons of effluent a day (MGD) directly to surface water resources, and another 45 MGD is proposed, as indicated in Table 9. City of Austin treatment plants account for most of the effluent discharged in Travis County; the four City plants are currently permitted to discharge a total of 97 MGD to the Colorado River. There are several privately owned treatment plants that discharge

Figure 12





Source: Espey, Huston & Assoc., Inc., 1979
Barton Creek Watershed Study

Figure 13
SEWAGE TREATMENT PLANTS
Travis County

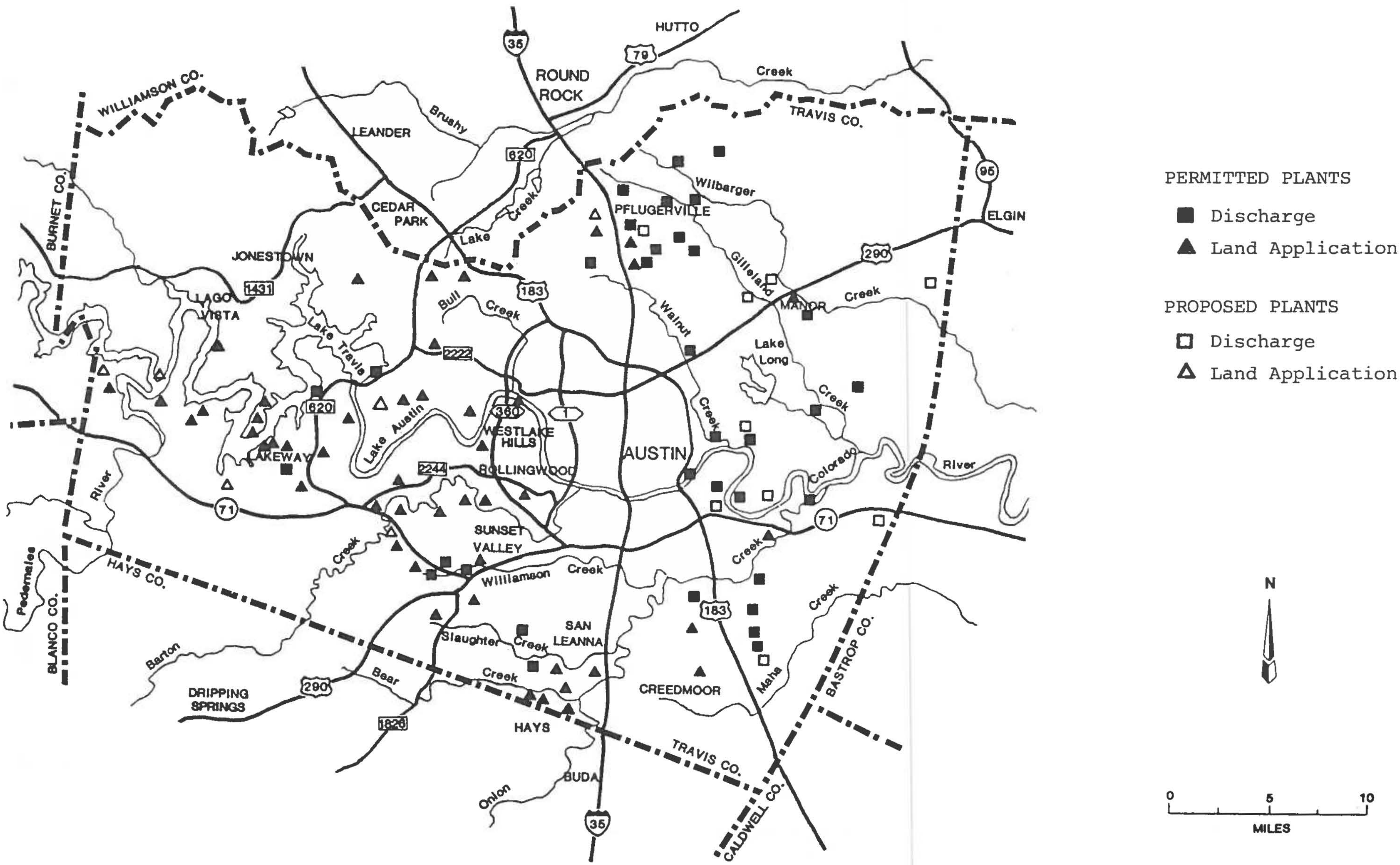


Table 9
SEWAGE TREATMENT PLANTS AND TREATMENT CAPACITY
IN THE AUSTIN AREA

	Travis County	Williamson County	Hays County
NUMBER OF CURRENTLY PERMITTED PLANTS			
- discharge	37	17	5
- land application	48	11	4
- **total**	**85**	**28**	**9**
NUMBER OF REQUESTED PLANT EXPANSIONS			
- discharge	3	2	0
- land application	1	1	0
- **total**	**4**	**3**	**0**
NUMBER OF PROPOSED NEW PLANTS			
- discharge	12	5	3
- land application	8	3	3
- **total**	**20**	**8**	**6**
DISCHARGE CAPACITY (in MGD)			
- permitted plants	96.28	29.39	11.74
- requested plant expansions	60.60	4.25	0.00
- proposed new plants	10.21	3.28	0.70
- **total**	**167.09**	**36.92**	**12.44**
LAND APPLICATION CAPACITY (in MGD)			
- permitted plants	9.98	2.19	0.12
- requested plant expansions	0.10	0.21	0.00
- proposed new plants	3.08	0.48	0.50
- **total**	**13.16**	**2.88**	**0.62**

Source: Texas Water Commission

relatively small volumes of effluent (less than one MGD) to the Colorado River or its tributaries.

These smaller plants are often referred to as "package plants," because many of their components come pre-assembled. The proliferation of package plants has become a concern. Unlike larger municipal plants, package plants usually do not have flow equalization facilities that can retain large inflows for treatment during non-peak hours. Without flow equalization facilities, large inflows must be handled immediately, and may not have the benefit of sufficient residency time in settling tanks and chlorination tanks. Also, most package plants do not have full-time staffs or continuous monitoring.

Larger municipal or regional plants may experience technical difficulties, but they have large, full-time staffs and continuous monitoring, and have a better capacity to produce a consistently higher-quality effluent than most package plants. Consequently, there is a trend developing to encourage hook-ups to larger collective systems and to discourage the proliferation of package treatment plant discharges and septic tanks. When municipal or regional wastewater services are not available or feasible, package plants are encouraged to use proper land application methods as much as possible.

Common land application methods include irrigation of golf courses, evaporation ponds, and evapotranspiration fields. Currently, there are 48 plants in Travis County using land application methods for a total of 10 MGD, and another 4 MGD is proposed, as indicated in Table 9. But there are limitations to the extent to which land application methods can be utilized. There are considerations for effluent volume, soil and slope suitability, proximity to surface water and groundwater resources, and air-borne pollution from spray irrigation. Although land application is not a panacea for wastewater disposal problems, it does offer alternatives to discharging effluent directly to surface water resources.

Most of the streams in the Austin area are intermittent, only flowing after it rains. Some streams are perennial, but they are normally low-flow streams. Under base flow conditions, receiving streams can easily be dominated by effluent. During the winter months, even the Colorado River can contain more treated wastewater than fresh water.

Almost all the water we use is returned to the environment, and as such, wastewater must be considered a water resource. Wastewater has potential for reuse, but the uses we can derive from wastewater depend on its level of treatment. Although effluent is predominantly water, it contains components that can have negative impacts on the quality of the receiving environment.

The natural decomposition of organic and mineral nutrients in effluent places a demand on the oxygen available in receiving waters, which can make the environment intolerable to fish. Nutrients can also stimulate the growth of algae and aquatic plants in receiving waters, which can change the natural characteristics of the stream, cause taste and odor problems, and limit recreational use. Advanced wastewater treatment techniques involve the removal of nitrogen and phosphorus in order to mitigate these environmental impacts, but nutrient removal adds significantly to the overall cost of wastewater treatment. Chlorination of effluent is necessary for proper disinfection, but too much chlorine can be toxic to fish. The pH and temperature of effluent is also important, because some species of fish are very sensitive to even slight changes in these parameters.

There are other possible point sources of water pollution. Sand and gravel extraction activities along the Colorado River can contribute to the sediment load of the river. Many homes in outlying areas are not serviced by municipal utilities and rely on septic tanks, and septic tank leaks can contribute to water pollution. Improper storage and transport of hazardous materials can lead to spills that can cause water pollution.

3.5 Groundwater Resources

Groundwater is a valuable natural resource that is generally abundant in the Austin area. But groundwater is not an inexhaustible resource, and it may be susceptible to contamination from a number of sources.

Although the City of Austin uses surface water reservoirs for its municipal water supply, some people in the surrounding area have used well water for many years. And as the surrounding area continues to grow, more and more people are becoming dependent on groundwater for their drinking water and more wells are being drilled, as shown in Table 10.

3.5.1 Southern Edwards Aquifer

The limestone of the Edwards Aquifer is often characterized by many pores and fractures, through which recharge can rapidly move. Human activities, such as overpumping or pollution, may have adverse effects, which are readily transmitted through the aquifer system.

Limestone landscapes typically have thin soils, through which little natural filtration of recharge occurs. The Edwards is perhaps more sensitive and vulnerable to contamination than any other aquifer in Texas. The actual extent of the filtration capacity of the unsaturated zone of the aquifer is still uncertain. Data collected from Barton Springs and selected wells indicate that the Edwards Aquifer seems to be susceptible to contamination, particularly from sediment and fecal bacteria. Potential sources of groundwater pollution in the area include:

- urban and agricultural runoff
- effluent discharges to surface waters
- land application of effluent
- leaking sewer lines and septic tanks
- leaking oil pipelines
- leaking underground and above ground facilities for storage of hazardous materials
- spills during the transportation of hazardous materials
- landfills
- intrusion of brackish water

Continuing urbanization can have negative impacts on groundwater resources. Stormwater runoff contributes significantly to aquifer recharge,

Table 10
WELLS DRILLED IN THE AUSTIN AREA

Fiscal Year*	Travis County	Williamson County	Hays County
1980	73	137	125
1981	80	142	136
1982	82	139	115
1983	161	167	219
1984	288	196	271
1985	362	307	515
1986	266	265	371

*October 1 to September 30

Source: Texas Water Development Board

so both the quantity and quality of this inflow are important considerations. Additional impervious cover normally corresponds to an increase in the volume of stormwater runoff. This generally implies that more pollutants are entering the aquifer, but this does not necessarily imply that more recharge is available to the aquifer. First of all, more impervious cover reduces the amount of surface area through which recharge can occur. Secondly, even though the volume of runoff is increased, only so much of this runoff can percolate into the ground at a time; consequently, more runoff flows into surface streams. Thirdly, even though surface streams that cross the aquifer contribute significantly to recharge, the stream bottoms can only accept so much infiltration at a time; consequently, much of this flow continues rapidly downstream to cause flooding, erosion, and pollution problems.

Local wells and Barton Springs are good indicators of groundwater contamination in the aquifer. Soon after major rainfall events, Barton Springs is sometimes closed because of extreme turbidity and high fecal coliform counts associated with stormwater runoff. In 1979, Barton Springs was closed for several days because of a leaking sewer line in Barton Creek. Table 11 gives closings for Barton Springs in recent years.

There is increasing concern over the amount of water withdrawn from the Edwards Aquifer, as more and more people in the Austin area depend on groundwater as their sole source of drinking water. Although the City of Austin does not directly withdraw drinking water from the aquifer, many outlying municipalities, such as Buda, Hays, Mountain City, San Leanna, and Sunset Valley are dependent on the aquifer as their sole source of drinking water. Also, there are four water supply corporations that withdraw water from wells drilled into the aquifer.

In 1982, the total pumpage from all wells drilled into the southern Edwards was about 3.4 million gallons per day (MGD). Currently, average daily pumpage rates are estimated to be at 5 to 6 MGD. By the year 2000, it is estimated that total pumpage from the aquifer will be about 8.5 MGD.

In the long-term, natural recharge to the aquifer equals natural discharge, which can be assumed to be the average discharge at Barton Springs, 32 MGD. The actual volume of water in the aquifer can vary considerably with weather conditions, but the average amount of water available in the aquifer is about 98 billion gallons. Even though there is still a lot of water in the aquifer, decreasing the amount of groundwater in storage through pumpage can have some significant effects: diminishing the flow at Barton Springs; increasing the concentration of pollutants in the aquifer by volume; and allowing the encroachment of brackish water.

Barton Springs is not only of recreational and historical value; it has significant economic value. Annually, more than 300,000 paid attendees visit the Barton Springs swimming pool. Also, the discharge from Barton Springs contributes to the volume of water in Town Lake, and thereby to the City of Austin's municipal water supply. The overall significance of this contribution has been debated, but during the winter months, water is not normally circulated through the area lakes, thereby making the contribution of Barton Springs to the municipal water supply more important. Substantial increases of groundwater withdrawals from the aquifer could lead to the

Table 11
BARTON SPRINGS CLOSINGS

Year	Number of Days Closed for Year		Dates of Closings
1980	9	March	26, 27
		April	13
		May	9, 13 - 16, 22
1981	30	May	25 - 31
		June	1 - 4, 11 - 30
		July	1 - 3
		August	19
		October	6 - 10
1982	26	March	22 - 25, 27 - 30
		April	20 - 26
		May	6, 7, 13 - 18, 24
		September	20, 21
1983	19	May	11 - 13, 20 - 23
		June	16, 17
		July	16
		August	9, 10
		September	7, 11, 19 -21
		October	11, 12
1984	21	October	7 - 9, 11 - 15, 19 -31
1985	21	May	22
		June	6 - 10
		July	21
		August	26
		September	23, 30
		October	1, 15 - 17, 19 - 22, 27, 29, 30
1986	26	May	1, 2, 10 -13, 15, 16, 18, 19, 23
		June	18
		September	6, 7
		October	8, 12 - 15, 20, 22 - 27

Barton Springs is officially open between the latter part of March and October 31. But during this season of operation, occasional lapses in water quality may cause the pool to be temporarily closed for public health and safety reasons. Runoff that recharges the aquifer naturally contains some sediment and fecal bacteria from animal sources, but urbanization and agriculture can increase these amounts significantly. Rainfall events of an inch or more can result in a great deal of runoff with some high pollutant loads. Fecal bacteria cannot live more than 48 hours outside an animal host, but much of the runoff that recharges the aquifer in the Barton Creek watershed reaches Barton Springs in just a few hours. Policy states that the pool will be closed for 48 hours after any rainfall event of one inch or more in the Barton Creek watershed to allow sufficient time for fecal bacteria to die off. Runoff that recharges the aquifer in the other watersheds below Barton Creek usually takes a week or more to reach Barton Springs. By this time, any fecal bacteria transported in the water have already died off, but large amounts of sediment from these relatively more developed areas may still be discharged at Barton Springs, causing the pool to be closed for 24 hours to allow the water to clear. During long rainy stretches, the pool may be closed for several days. In 1981, the pool was closed for an extended period of time because of the Memorial Day Flood and its aftermath.

Source: City of Austin, Parks and Recreation Department destruction of this, one of Austin's most valued natural resources.

3.5.2 Northern Edwards Aquifer

The northern Edwards Aquifer is susceptible to contamination from the same sources as the southern Edwards Aquifer, and for similar reasons. But of particular concern in the northern Edwards is the large number of wastewater treatment plants located in the area. Approved and pending permits would allow 6 MGD of effluent to enter water courses, which poses a threat to groundwater quality, since these streams contribute to aquifer recharge.

The area of the Jollyville Plateau has been extensively studied by the City of Austin, Department of Environmental Protection. This area has been found to contain several Critical Environmental Features, including springs and seeps, and caves and sinkholes. These features often support fragile or rare ecosystems, particularly susceptible to the adverse impacts of human activities.

As the population of the Austin area continues to grow, more people in Williamson County are depending on water from the northern Edwards Aquifer. The major municipal users of the northern Edwards are Georgetown and Round Rock; other municipal users include Jarrell, Bartlett, and Pflugerville.

The total pumpage from the northern Edwards Aquifer has increased steadily over the last few years. If current rates of withdrawal continue to be maintained, a major drought would result in severe water shortages for many municipalities that depend on the aquifer.

New, large municipal water systems that will use the northern Edwards are already being planned and constructed. Although Round Rock has added surface water capabilities to its system, and Georgetown is planning to do the same, these supplemental supplies may only compensate for some of the future growth of the the two cities, without effectively reducing their present groundwater pumpage.

Much of the projected additional development of the northern Edwards will be at the expense of spring flow. It is likely that, as extended pumpage lowers groundwater levels in the aquifer, San Gabriel Springs and Berry Springs will cease to flow, or become only intermittent. Salado Springs will probably continue to flow for a much longer period of time, but at rates substantially less than previously observed.

3.5.3 Other Aquifers

The Edwards is the most productive aquifer in the Austin area, but many rock units in the Austin area other than the Edwards contain quantities of groundwater. Most important among these are the Trinity Group Aquifer and the Alluvium and Terrace Deposit Aquifer. Current data on groundwater usage from these aquifers are not available, but historical data show a heavy usage of these groundwater resources in the Austin area, and that these aquifers may be susceptible to overdraft and contamination from a number of sources.

The recharge zone of the Trinity Group Aquifer is largely in rural areas. In the Austin area, this aquifer may not be as subject to the deleterious effects of urban runoff as the Edwards, but Trinity groundwater may still be exposed to other possible sources of contamination, including agricultural activities, oil pipelines, underground storage tanks, and septic tanks. Many rural households, especially in western Travis County, depend on Trinity groundwater, as well as the Cities of Jonestown and Leander.

Even though the materials of the Alluvium and Terrace Deposit Aquifer generally has a better natural filtration capacity than the often vugular limestone of the Edwards Aquifer, it is still susceptible to contamination. Sand and gravel, just as any medium, can only act as a filter to a certain extent. And because the Alluvium and Terrace Deposit Aquifer is generally a shallow groundwater resource (typical wells pump from a depth of 20 to 40 feet), it is particularly sensitive to the inflow of polluted surface water. Many parts of the aquifer are located in urbanized areas in and around Austin, and pollutants in stormwater runoff are an important concern. Another major concern is the disposal of effluent into streams that recharge the aquifer. In eastern Travis County, many households and small communities, such as Garfield and Manor, use groundwater from the Alluvium and Terrace Deposit Aquifer, and the City of Austin uses groundwater from the aquifer to air-condition Palmer Auditorium and supply water for Deep Eddy Pool.

In the Austin area, the Edwards Aquifer generally parallels IH-35, which is a high-growth corridor. Consequently, usage of Edwards groundwater is increasing rapidly. But a considerable number of people are also attracted to more rural areas to the east and west of Austin, and there is every reason to believe that usage of the Trinity Group Aquifer and the Alluvium and Terrace Deposit Aquifer will also increase, but perhaps at a lesser rate than the Edwards.

3.6 Environmental Resource Inventory

In order to better protect our natural resources, it is important to establish a detailed inventory of those resources. The Department of Environmental Protection is currently undertaking an extensive effort to inventory biological and geological resources in the Austin area. This inventory involves location and classification of Critical Environmental Features (CEF's) and Environmentally Sensitive Areas (ESA's).

CEF's are defined as features that are of critical importance to the protection of one or more environmental resource. Although provisions for protection of CEF's in the City Code are directly related to water quality concerns, the protection provided for CEF's also has positive ecological implications. CEF's include:

- caves, sinkholes, and major fractures, because they may be points of significant groundwater recharge
- canyon rimrocks and steep bluffs, because of the potential for massive slope wasting
- springs and seeps, because they contribute to streamflow
- wetlands, because they serve to filter runoff entering water bodies

ESA's are defined as areas of sensitive environmental resources that are of high priority for preservation and special land use consideration. Unlike CEF's, the consideration of ESA's may not directly be associated with water quality concerns, and as such ESA's may not be afforded outright protection under current provisions of the City Code. However, more incentives are being considered to encourage land developers to dedicate ESA's for preservation. ESA's include but are not limited to:

- priority riparian woodlands
- priority upland woodlands
- rare, threatened, or endangered biological communities (priority grasslands and priority canyons)
- rare, threatened, or endangered species habitat (black-capped vireo, golden-cheeked warbler, rare cave fauna)
- priority aquatic habitat
- unique geological features

Following are more detailed descriptions of some of these environmentally sensitive features found in the Austin area.

3.6.1 Riparian Woodlands

Riparian refers to the banks of streams. In the Austin area, riparian woodlands occur along the Colorado River and in the floodplains of the numerous creeks in the area. Riparian woodlands have a closed or nearly closed canopy and are composed of a diversity of native bottomland tree species, as well as many types of shrubs, vines, and grasses. The dominant trees of riparian woodlands are those described for the lower terraces and floodplains in Section 2.2.4. Common shrubs and understory species include buttonbush, viburnum, American beauty berry, roughleaf dogwood, yaupon holly, mustang grape, poison ivy, and greenbrier. Ground cover may include Virginia wildrye, inland sea oats, rescue grass, frost weed, and many other species.

Because of the available cover and proximity to water, riparian woodlands generally support a variety of animal life. Some of the oldest and largest trees in Austin can be found in these areas. Development in floodplains and waterway modifications and maintenance are particular threats to these important natural habitats.

3.6.2 Priority Upland Woodlands

Upland woodlands can be found in the Hill Country west of Austin and on high terraces east of Austin. The upland woodlands on the high terraces east of Austin are dominated by post oak and cedar elm. Additional common woody species may include eastern red cedar, mesquite, blackjack oak, and sugarberry. The understory may include yaupon, agarita, greenbrier, prickly pear, and tasajillo. In the Hill Country, the upland woodlands are dominated by live oak and Ashe juniper. Spanish oak and cedar elm may also be abundant. The understory may be comprised of madrone, agarita, Texas persimmon, sumac, shin oak, and hackberry. Grasses include Texas wintergrass, curly mesquite, Texas grama, little bluestem, sideoats grama, buffalograss, and tall dropseed.

Upland woodlands also provide habitat for a wide variety of wildlife, including some rare habitat specialists such as the golden-cheeked warbler and the black-capped vireo. Indiscriminate brush clearing and widespread removal of junipers (cedars) are particular threats to the integrity of upland woodlands in the Hill Country.

3.6.3 Golden-cheeked Warbler Habitat

The golden-cheeked warbler (Figure 14) is a rare bird inhabiting the mature upland woodlands of the Hill Country. It has one of the most restricted ranges of habitat preferences of any North American bird. The entire nesting range of the species is within Texas--the only such endemic bird species in the state. The golden-cheeked warbler is listed as a "protected non-game" species by the Texas Parks and Wildlife Department.

At present, the golden-cheeked warbler is still a locally common species in appropriate habitat west of Austin, but the amount of habitat available for the species is declining seriously. Typical golden-cheeked warbler

Figure 14

Black-capped Vireo
Vireo atricapillus

Golden-cheeked Warbler
Dendroica chrysoparia

Source: Kutac & Caran, 1976
Bird Finding and Naturlists Guide for the Austin, Texas, Area

habitat in the Austin area occurs on canyon slopes, ridge tops, or plateau areas, where the dominant vegetation is mature upland woodlands. Warblers take advantage of the abundance of juniper trees by stripping off pieces of the stringy bark to make their nests. Individual pairs of golden-cheeks may occupy territories of three to ten acres in size. Although golden-cheeks are known to occur in cedar brakes adjacent to suburban development, they do not occur within typical residential areas.

3.6.4 Black-capped Vireo Habitat

The black-capped vireo (Figure 14) is a species of small bird that has been declining seriously in much of its breeding range. Its primary center of distribution is now in the Texas Hill Country. The species is presently under study by the U.S. Fish and Wildlife Service for federal listing as an endangered species.

The black-capped vireo is a habitat specialist and primarily occurs in pockets of optimum habitat widely separated from other groups of vireos. Optimum habitat for black-capped vireos in the Austin area combines the following features:

- a second-growth brushy habitat, where evidence of a previous fire is often indicated
- shin oak and sumac are prominent, and juniper does not comprise more than 70% of the canopy
- canopy cover ranges from 30% to 70% and canopy heights range from 5 to 15 feet with an irregular aspect
- the habitat occurs on ridges, plateaus, or slopes normally along or near a slope break of a canyon head
- there is normally a prominent habitat "edge" feature, such as the boundary between brush and grasslands

At present, a total of about 60 pairs of black-capped vireos are known to occur in western Travis County. Each vireo occupies a territory of about five to ten acres. Rarely, isolated breeding pairs occur in appropriate habitat. More frequently, two to 30 pairs may occur in extended areas of good habitat. Two known concentrations of the species are in and near the Wild Basin Wilderness Preserve and near Four Points (FM 2222 at FM 620).

3.6.5 Priority Grasslands

Much of the Great Plains was once covered with extensive grasslands, but native prairie has become one of our most endangered habitats. Along with the loss of this important natural habitat, America has seen the decline of animal species such as the buffalo, antelope, and prairie chicken.

Much of the land east of Austin was once prairie land covered with a variety of tall native grasses and wildflowers, but because of farming, grazing, and development, very little undisturbed native prairie habitat can still be found in the Austin area.

Grasses that may be considered indicator species of the native prairie habitat in the Austin area include tall dropseed, Texas cupgrass, big bluestem, Indiangrass, and little bluestem. Other species may include Texas wintergrass, side-oats grama, Florida paspalum, and silver bluestem. Prairie larkspur and foxglove are flowering plants associated with the native prairie habitat, but they are increasingly harder to find. Although the tall-grass prairie vegetative community is extremely rare and endangered, few of the component plant species themselves are actually rare.

Native animals still common in grasslands include eastern meadowlark, dickcissel, common nighthawk, savannah sparrow, Texas rat snake, Gulf Goast toad, and many other species.

3.6.6 Springs and Seeps

Groundwater resources are abundant the Austin area, and in locations where surface fractures and exposed lithologic contact zones are present, it is not uncommon to find springs and seeps. Springs and seeps not only contribute to stream flows, they often support a diversity of plant and animal life, and provide many aesthetically pleasing surroundings. The following plants are particulalry adapted to a cool, moist environment and are used as indicators of the presence of springs and seeps:

Adiantum capillus-veneris	maidenhair fern
Arisaema dracontium	green dragon
Bignonia capreolata	cross-vine
Dicanthelium lanuginosum	wooly dicanthelium
Galium circaezans	woods bedstraw
Lindera benzoin	spicebush
Muhlenbergia schreberi	nimblewill grass
Platanus racemosa	eastern sycamore
Thelypteris kunthii	southern shield fern
Viola missouriensis	Missouri violet

The addition of impervious cover and the alteration of drainage patterns over localized recharge areas can diminish the flow of seeps and springs, potentially drying them out completely. Runoff from construction sites can convey silt into springs, and into springfed pools and streams. Siltation can plug up or permanently fill in such areas, and impact sensitive aquatic communities.

3.6.7 Canyon Heads and Rimrocks

Many drainageways in western Travis County have incised canyon heads along the perimeter of the Jollyville Plateau. Such areas often contain sensitive environmental features that require particular attention to avoid damage from human activities. Canyon heads are often loci for springs and seeps, fragile plant communities, fragile hanging travertine deposits, and shelter caves with potential archaeological significance.

Canyon heads may be circumscribed by outcrops of resistant limestone layers called rimrocks, which commonly form the slope slope break between flatter uplands and steep canyons. Rimrocks may also be recognized by the following indicator plant species adapted to steep limestone substrates:

<u>Aquilegia canadensis</u>	wild columbine
<u>Asplenium resiliens</u>	blackstem spleenwort
<u>Buddleya racemosa</u>	wand butterfly-bush
<u>Cheilanthes</u> spp.	lipferns
<u>Pellaea</u> spp.	cliffbrake

Runoff from construction sites can impact points of groundwater discharge and fragile canyon ecosystems. Addition of impervious cover in areas near canyons can also enhance the velocity of runoff, which can multiply erosional forces acting on steep bluffs and rimrocks, to the point that massive slope wasting may occur.

3.6.8 Caves and Sinkholes

Caves and sinkholes are karstic features that may serve as important points of recharge for the Edwards Aquifer. Some sinkholes in the Austin area are quite large, and are avenues for significant recharge.

Construction around sinkholes can alter drainage patterns, possibly decreasing the amount of recharge. Also, runoff from construction sites can contain silt and other pollutants. Heavy disturbance can cause a sinkhole to collapse and reduce or even eliminate its recharge capacity.

These karstic features are also important habitat for many species, most of which are common and can live elsewhere, but some of which are specially adapted and unable to survive outside of the cool, dark cave environment. Some of the cave-adapted species (called troglobites) are widespread, occurring in many of the underground cavities in the area. Others, however, have evolved in and been isolated in very specific lcoations. Six such species of extremely local distribution have been petitioned for federal protection:

1) <u>Microcreagris texana</u>, a small (4 mm) blind pseudoscorpion known to exist only in Tooth Cave

2) <u>Leptoneta myopica</u>, a very small (1.6 mm), pale, long-legged spider with reduced eyes known to exist only in Tooth Cave

3) <u>Texella reddelli</u>, a small (2-3 mm), light yellowish-brown harvestman known to exist in five local caves

4) <u>Rhadine persephone</u>, a small (7-8 mm) beetle with rudimentary eyes, known to exist in Tooth Cave and Kretschmarr Cave

5) Texamaurops reddelli, a very small (2 mm) beetle known to exist in three local caves

6) Cylindropsis sp., a blind rove beetle known to exist only in Tooth Cave

The caves harboring these and other obligate cave-dwelling species are relatively small and are primarily located on private property subject to development. They are susceptible to human visitation and disturbance. Preservation of the biological diversity in caves in the Austin area depends on the protection of cave entrances, their local drainage areas, and in some cases the recharge areas for their subterranean waterbodies.

Human activities pose potential threats to these often fragile cave ecosystems. Construction activity can diminish or contaminate the inflow of moisture to caves, which can adversely affect the fauna dependent on that inflow. Application of pesticides in surrounding areas is a particular concern. Most cave entrances are not protected from visitation, and are thus susceptible to a great deal of human disturbance.

3.6.9 Wetlands

Small areas of wetlands may be found in the Austin area along the edges of bodies of water. Some of the most significant wetlands in the Austin area are associated with man-made features, such as Town Lake, Lake Long, and many stock and holding ponds.

Wetlands are characterized by hydric soils. These soils are usually saturated with water and may be periodically inundated. Indicator plant species include cattails, bulrush, spikerush, ferns, watercress, bald cypress, black willow, American water-willow, beakrush, sedges, smartweed, and arrowhead.

Wetlands not only serve an important water quality function in that they can filter runoff entering water bodies, they frequently provide important habitat for a variety of species, including some species of migratory birds. For example, the wetlands of Lake Long provide the largest inland nesting area in Texas for the least bittern. Wetlands can be impacted by heavy pollutant and sediment loads in stormwater runoff, and by alteration of water levels.

3.7 Nature Preserves

There are several places in the Austin area set aside as nature preserves (Figure 15). Some of these nature preserves protect unique natural resources, but most of these preserves are intended to set aside relatively unimpacted areas representative of various native habitats. By intent and design, most of these preserves have limited access and limited use, but they are all excellent places for interpretation of our natural systems.

3.7.1 City of Austin Nature Preserves

The City of Austin has established a system of nature preserves. There are currently eight preserves in the system, with a total of about 600 acres of representative native habitats. Following is a brief description of each of the City's nature preserves:

1) Austin Nature Center

Significant faulting runs through this preserve, creating a prominent displacement of over 100 feet. The fault reveals an excellent cross-cut of the geologic stratigraphy of the area. The preserve covers 60 acres and is at the western end of Zilker Park. The preserve offers a diversity of habitats, ranging from Edwards Plateau habitat above the fault, to Rolling Prairie habitat below the fault. There is also some riparian habitat where the preserve borders Town Lake. The preserve is moderately impacted by previous activities, including quarrying and Civilian Conservation Corps projects.

2) Barrow Preserve

This small preserve of six acres is located in northwest Austin, bordering a residential neighborhood overlooking Bull Creek. It is representative of steep Hill Country habitat, with small springs and seeps issuing from a canyon head that supports a diverse plant community, including some rare plants such as the plateau anemone. The preserve is also habitat for the golden-cheeked warbler.

3) Bee Creek Preserve

This preserve covers 60 acres just above Tom Miller Dam on Lake Austin. The preserve is representative of the dissected Hill Country terrain, with steep canyon walls. There is a small cave in the preserve, and the heavily wooded area is prime habitat for the golden-cheeked warbler.

4) Blunn Creek Wilderness Park

This is an urban nature preserve covering about 39 acres along Blunn Creek, which is a perennial stream. The preserve is representative of the Rolling Prairie habitat, with some immense live oaks giving way to a second growth of mesquite and hackberry. The preserve is important as an interpretive area, since it abuts Saint Edwards University and Travis High

School. The schools and the adjacent residential neighborhood also lend to the stewardship of the preserve.

5) Lake Long Indiangrass Prairie Preserve
This preserve covers 200 acres of remnant Blackland Prairie habitat along the north shores of Lake Long east of Austin. There is a diversity of prairie grasses and wildflowers in the preserve. A companion preserve at Lake Long includes some prime areas of post oak, elm, and eastern red cedar woodland.

6) Mayfield Preserve
This is a heavily wooded urban park that covers 22 acres adjacent to Laguna Gloria along Lake Austin. The land was willed to the City, expressly for use as a nature preserve.

7) Onion Creek Preserve
This is the most recent addition to the nature preserve system. It covers 180 acres along a bend in Onion Creek, just north of State Highway 71. The preserve includes riparian bottomland woodland habitat, with large pecan trees. Much of the preserve has been impacted by cattle ranching, but this area will be replanted and reclaimed as a bottomland tall grass prairie.

8) Walnut Creek Preserve
This preserve covers 26 acres along Walnut Creek, near LBJ High School in eastern Austin. The preserve contains bottomland hardwood forest with dense undergrowth.

The City's system of nature preserves is managed by the Parks and Recreation Department, with technical support from the Department of Environmental Protection.

3.7.2 Other Nature Preserves

Wild Basin Wilderness Preserve is located west of Austin on Loop 360. The preserve is owned by the County, but managed by a committee of citizens as a non-profit corporation. Wild Basin covers just over 200 acres of Hill Country terrain, offering an excellent representation of diverse habitats, ranging from dense upland woodlands to savannas. The preserve is prime habitat for the golden-cheeked warbler and the black-capped vireo. There is a wide diversity of plants, including some rare plants. The preserve is one of the most important environmental education facilities in the Austin area.

Westcave Preserve is located in the extreme southwest corner of Travis County near the Pedernales River. The land was originally acquired by the Nature Conservancy for preservation, but now the land is owned by the Lower Colorado River Association. The preserve covers 30 acres of spectacular Hill Country terrain, including a perennial stream with a waterfall, and a large overhang with impressive travertine formations. The preserve is also prime habitat for the golden-cheeked warbler and the black-capped vireo.

4.0 EFFORTS TO PROTECT ENVIRONMENTAL QUALITY

The impacts of human activity on environmental quality are becoming generally more apparent in the Austin area. But the extent to which efforts have been made to protect the environment seems to evidence an increasing level of public awareness and concern. This section provides a description of existing and proposed environmental protection measures applicable to the Austin area.

Mountain Laurel
Sophora secundiflora

Source: Lynch & McGowan, 1981
Native & Naturalized Woody Plants of Austin & the Hill Country

4.1 City of Austin Environmental Protection Measures

The City of Austin has set forth a number of environmental protection measures, several of which are progressive on the national level. Austin is one of the few major cities in the nation with a department for environmental protection and a comprehensive ordinance addressing urban runoff.

4.1.1 Waterway Development Ordinance

The Waterway Development Ordinance, often referred to as the "Creek Ordinance," requires permits for development on and along all waterways within the corporate limits of Austin. The permit application must include a description of appropriate erosion and sedimentation controls. The Department of Environmental Protection reviews plans for compliance with this ordinance.

An important provision of the ordinance is the maintenance of the "natural and traditional character of the land and waterway." This wording is very general, and City staff guidelines and procedures are frequently taken exception to by development permit applicants. Despite this drawback, the Creek Ordinance remains a valuable instrument in the protection of Austin's urban waterways.

4.1.2 Comprehensive Watershed Ordinance

The Comprehensive Watershed Ordinance was recently enacted, in March, 1986. The ordinance applies to all non-urban watersheds in the corporate limits and the five-mile ETJ. The ordinance is a combination of regulations enabled through subdivision legislation and the Texas Water Code, which allows cities to establish and enforce water pollution control programs. Developments approved before the enactment of this ordinance are grandfathered, but they may still be affected by the prior special watershed ordinances (i.e., Lake Austin, Barton Creek, Williamson Creek, Onion Creek, Slaughter Creek, and Bear and Little Bear Creeks). The Department of Environmental Protection reviews plans for compliance with this ordinance.

The strictest protection measures in the Comprehensive Watershed Ordinance are afforded to watersheds that are associated with drinking water supplies. Such measures include limitations on density of development and on amounts of impervious cover. General provisions that apply to all watersheds affected by the ordinance include:

- installation and maintenance of appropriate erosion and sedimentation controls for all construction sites
- limitations on developing on slopes over 15 percent
- mandatory setbacks from Critical Environmental Features (see Section 3.6)

- establishment of Critical Water Quality Zones in which no development is allowed, and adjacent Water Quality Buffer Zones in which only limited development is allowed

4.1.3 Erosion and Sedimentation Control Manual

All erosion and sedimentation control measures required by City ordinances must be in accordance with specifications described in the City's Erosion and Sedimentation Control Manual. The manual details proper construction, installation, and maintenance of temporary control structures, such as triangular filter dikes, rock and brush berms, and stabilization of construction site entrances, and permanent control structures such as gabions, rip-rap, and grass-lined swales. The manual also details procedures for dust control and tree protection during construction, and procedures for revegetation of the site after construction. The ESC Manual is compiled and revised by the Department of Environmental Protection.

4.1.4 Stormsewer and Waterway Industrial Waste Ordinance

This ordinance prohibits certain discharges and regulates other discharges into the City's stormsewer system and waterways. The City's stormsewer system is not connected with the City's sanitary sewer system; stormwater runoff and waste discharges that enter the stormsewer system are directly deposited in our waterways, without the benefit of treatment.

Currently, the Austin-Travis County Health Department enforces this ordinance, but this responsibility is being transferred to the Department of Environmental Protection. All discharges of industrial wastes outlined in the ordinance must be permitted. Certain facilities must utilize grease traps or catch basins to filter runoff before it enters stormsewers, whereas some facilities must utilize holding tanks and may not discharge to stormsewers.

This ordinance can be more broadly applied to affect non-industrial discharges to stormsewers. For instance, it is not uncommon for people to dispose of many kinds of household wastes down stormsewers. But substances such as motor oil, brake fluid, transmission fluid, and anti-freeze are not acceptable discharges to stormsewers. Even the disposal of leaves or dirt down a stormsewer could be construed as an illegal discharge.

4.1.5 Sanitary Sewer Industrial Waste Ordinance

This ordinance prohibits certain discharges and regulates other discharges to the City's sanitary sewer system. Some substances, such as corrosives and abrasives, can accelerate the attrition on sewage pipes and treatment plants. Effluent of inferior quality may be discharged to the receiving environment if certain substances are not effectively filtered out, or if they disrupt the biochemical treatment process.

The Industrial Waste Control Division of the Water and Wastewater Utility enforces this ordinance. All discharges of industrial wastes outlined in the ordinance must be permitted. Certain facilities must utilize grease traps or catch basins to filter wastes before they enter the sanitary sewer system, whereas some facilities must utilize holding tanks and may not discharge to the sanitary sewer system.

This ordinance can be more broadly applied to affect non-industrial discharges to the sanitary sewer system. For instance, it is not uncommon for people to dispose of many kinds of household wastes down the sink or toilet. But substances such as poisons, acids, and solvents are not acceptable discharges to the sanitary sewer system.

4.1.6 Wastewater Treatment and Disposal Policies

In 1979, the City Council set forth the City's Package Treatment Plant Policy. The policy recognizes potential problems with the proliferation of small, private treatment plants that discharge effluent to streams in the Austin area. The policy calls for the City to routinely inspect these facilities. The policy also encourages land application methods in water-supply watersheds as well as enhancing effluent quality.

In 1985, the City Council established the City's Policy on Wastewater Treatment Permits and Effluent Limitations. The policy focuses on protecting water quality in the Colorado River. The City will review all wastewater disposal permit applications and make recommendations on treatment levels to the Texas Water Commission. The City will also periodically review all applicable water quality standards and make recommendations to the appropriate authorities.

In September, 1986, the City Council resolved to oppose any effluent discharge in the contributing zone or recharge zone of the Edwards Aquifer if, after review by the City, that discharge were considered a threat to water quality.

4.1.7 Septic Tank Ordinance

This ordinance requires the permitting and inspection of septic tanks. The ordinance is enforced by the Austin-Travis County Health Department. The health officer reviewing the permit application determines site suitability (such as soils and slopes), proper construction and installation according to established standards, and minimum size of drainfield. The ordinance requires the distancing of septic tanks from water supplies, and the proper disposal of septic tank sludge.

4.1.8 Hazardous Materials Registration and Storage Ordinance

The major purposes of this ordinance are to protect public health and safety, and to protect surface water and groundwater supplies from possible contamination. The ordinance applies to all points within the corporate limits and to water supply watersheds within the City's five-mile ETJ.

The ordinance requires permits to be obtained from the Fire Department for the storage of materials classified as hazardous. Such materials must also be inventoried and registered with the Fire Department, and an emergency contingency plan must be submitted. The ordinance describes specifications for new and existing storage facilities and underground storage tanks, and outlines provisions for monitoring and inspections. The Department of Environmental Protection inspects and monitors underground storage tanks.

4.1.9 Recycling Program

The Solid Waste Services Division of the Department of Transportation and Public Services began operating its recycling program in October, 1982. Since then, the program has continued to expand service to more parts of the Austin area, and the amounts of materials collected have steadily increased, as indicated in Table 12. The program helps achieve two important environmental goals: to decrease the amount of natural resources consumed and to decrease the amount of material landfilled. The City is also able to derive revenues through recycling of the materials collected.

4.1.10 Home Chemical Waste Collection Day

In April, 1986, the City of Austin, in cooperation with the League of Women Voters, the Sierra Club, the Housing Resources Association, the Austin Organic Gardeners, and Keep Austin Beautiful, sponsored a Home Chemical Waste Collection Day. It was the first event of its kind held in Texas, and it was a huge success. In April, 1987, the event was held again, with even greater success.

Table 13 shows the large amounts of household chemical products collected during these events. Hazardous materials were packed securely in drums, and transported to a federally approved disposal site by a licensed waste management firm, thereby keeping these materials out of our landfills and treatment plants. Many of the materials collected, though, were recyclable or reusable, such as motor oil, fertilizer, and paint and other building products. The reusable paint and building products were given to civic organizations to repair housing for needy families in our community.

The great deal of public support for Home Chemical Waste Collection Day is evidence of two things: that the average household produces a significant quantity of hazardous waste, and that the people of Austin are concerned about disposing of these wastes in a safe and environmentally conscious manner.

4.1.11 Zoning and Subdivision Ordinances

Federal and state legislation enables a city to enact and enforce zoning and subdivision controls. Such controls are considered constitutional police powers of a city, for the purposes of protecting public health, safety, and

Table 12
CITY OF AUSTIN RECYCLING PROGRAM
(Amounts of Materials Collected)

The following table gives data on the City of Austin's Recycling Program, which is operated by the Department of Public Works, Solid Waste Services Division.

Year	Glass (tons)	Metal (tons)	Paper (tons)	Totals (tons)
1983	266.93	43.03	579.54	889.50
1984	612.18	89.35	1562.07	2263.60
1985	740.49	125.53	2615.58	3481.60
1986 (through June)	388.95	75.87	1507.17	1971.99

Source: City of Austin
Transportation and Public Services Department

Table 13
HOME CHEMICAL WASTE COLLECTION DAY
Summary Sheet

	1986	1987
Participants	450	650
Recyclable/Reusable Materials		
paint[1]	500 gal	700 gal
motor oil[2]	600 gal	1300 gal
fertilizer[3]	150 lb	200 lb
car batteries[4]	50	216
flammables[5]	150 gal	200 gal
Hazardous Household Chemicals Sent to Federally Approved Disposal Sites	149 drums	120 drums*

[1]given to community service organizations

[2]given to waste oil service (some to Fire Dept. for training)

[3]given to Water and Wastewater Utility for grounds maintenance

[4]given to battery company

[5]given to Fire Dept. for training

*The turnout for 1987 was greater than for 1986, but this decrease in drums reflects more efficient packing and better identification of non-hazardous and recyclable/reusuable materials.

welfare. Also, regulations on the grounds of protecting aesthetic value and public morals have often been legally upheld. In environmental terms, the City's police power is important in regulating land use and the density of development.

The City's Zoning Ordinance regulates land use. There are many zoning classifications. For example, residential land use can be classified either as single-family or multi-family, and commercial land use can be classified as either office or retail. Zoning can help prevent nonconforming land uses, such as noisy industries adjacent to a residential neighborhoods. Limiting land use in Environmentally Sensitive Areas is an important aspect of zoning. However, the City's zoning power only extends to the corporate limits; particular land uses, per se, cannot be imposed in the ETJ. The City often encourages Planned Unit Developments (PUD's) in the ETJ. PUD's are usually composed of some combination of office buildings, retail establishments, and single-family and multi-family residences. All of these land uses are typically clustered together, in order to maximize the amount of continuous green space in the development. Runoff from the concentrated area of impervious cover can be controlled through detention and filtration basins.

Whereas the Zoning Ordinance regulates what type of development can occur on a certain parcel of land, the Subdivision Ordinance regulates in what manner that development can proceed. Specifications in the Subdivision Ordinance include approval of subdivision plans, layout of streets and sidewalks, drainage, lot sizes, and installation of utilities. The Subdivision Ordinance applies to the corporate limits and the ETJ, making it one of the most important ways the City can extend environmental protection measures into the ETJ.

4.1.12 Landscaping Ordinance

The Landscaping Ordinance applies to the corporate limits. The ordinance prohibits indiscriminate clearing or stripping of the natural vegetation on a lot. The ordinance requires that site development plans include a tree inventory of the lot, an indication of how the maximum number of trees can be retained, and an indication of how those trees retained can be protected from disturbance during construction. The ordinance states that the existing natural character of the landscape should be preserved to the greatest extent reasonable or feasible, especially native trees. The Department of Environmental Protection reviews plans for compliance with this ordinance.

4.1.13 Tree Ordinance

The Tree Ordinance offers protection to all trees within the corporate limits having a trunk circumference of 60 inches or more, as measured 4.5 feet above the ground. No protected tree can be removed without prior approval from the City Arborist in the Department of Environmental Protection.

4.1.14 Parkland Dedication Ordinance

This ordinance is part of the City's Subdivision Code, and it is administered by the Parks and Recreation Department. The ordinance requires that a certain percentage of the total land in a proposed subdivision be dedicated as parkland. Although the primary purpose of the ordinance is to ensure the sufficient allocation of land for neighborhood parks in newly developed areas, the ordinance does have some implications for protection of natural environmental features.

If a developer dedicates land that is officially classified as an Environmentally Sensitive Area, he can be awarded partial credit toward his total parkland dedication requirement. Since Environmentally Sensitive Areas, such as remnant native prairie and rare bird habitat, are not afforded outright protection under the existing legal framework, this ordinance offers some measure of incentive not to develop such areas.

4.1.15 Hill Country Roadway Ordinance

The purpose of this ordinance is to preserve the natural character and scenic vistas found along Hill Country roadways. The roadways affected by the ordinance include: Loop 360 (from U.S. Hwy. 290 to U.S. Hwy. 183); RR 2222 (from Highland Hills Dr. to FM 620); RR 2244 (from Loop 360 to Texas Hwy. 71); and FM 620 (from Texas Hwy. 71 to U.S. Hwy. 183).

The intent of this ordinance is effected by regulating development activities. The ordinance limits construction on steep slopes, amounts of impervious cover, building heights, amounts of reflective glass on buildings, and the number of driveways accessing Hill Country roadways. The ordinance requires underground utilities, the greatest feasible use of naturally compatible materials for building and native plants for landscaping, and the dedication of natural areas. The ordinance also outlines specifications for commercial signs, vegetative buffer zones parallel to roadway easements, and vegetative screening of developed properties.

4.1.16 Annexation Activity

The City can increase its areal size through annexation. Annexation activity is enabled through state legislation. A city may annex in any one calendar year territory equivalent in size to ten percent of the total corporate area of the city as of the first day of the calendar year. If a city does not annex the total amount of territory it is authorized to annex in any one calendar year, such unused allocation may be carried over and used in subsequent years; however, the city may not annex in any one calendar year an amount of territory in excess of 30 percent of its total area as of the first day of the calendar year. When a city annexes additional territory, the ETJ of the city expands in conformity with the annexation.

Annexation is an important means through which the City can derive additional revenues through taxation and extend its full ordinance power, which broadens the extent of environmental protection. But the City is required to provide annexed areas with full municipal services within a certain time; this provision may financially limit the City's capability to annex.

Over the past few years, the City of Austin has acquired a significant amount of territory under limited-purpose annexation. In these areas, the City cannot levy municipal taxes, so it derives no additional revenues from the process; also, the ETJ cannot be extended from these areas. But in these areas, the City is not required to provide any municipal services, and it is still able to extend its full ordinance power. These provisions make limited-purpose annexation an affordable way for the City to regulate land use in outlying areas. The City's limited-purpose annexation policy favors broader environmental protection, but it has received criticism from many people affected by it, and has drawn state-wide attention because of its aggressive application, prompting some reconsiderations of the enabling legislation.

4.1.17 Air Quality Control Measures

The City of Austin has no comprehensive air quality ordinance, but it has implemented some air quality control measures. The Electric Utility maintains air pollution control devices at the City's electric power plants, in accordance with state and federal regulations. The Water and Wastewater Utility maintains odor controls at the City's sewage treatment plants. Open burning is prohibited by ordinance within the corporate limits of Austin, and the Fire Department enforces this ordinance. The Erosion and Sedimentation Control Manual calls for water sprinkling at construction sites to control dust. The City recently passed an ordinance regulating smoking in public places, and the Austin-Travis County Health Department enforces this ordinance. ATCHD currently inspects air quality complaints and takes air quality samples, but these responsibilities are being transferred to the Department of Environmental Protection.

4.1.18 Noise Abatement Measures

The City of Austin has no comprehensive noise ordinance, but it does have some regulations addressing nuisance noise from the following sources: neighborhood parks, establishments with amplified music, drive-in theaters, vehicles with loud speakers, and animals. The Zoning Ordinance places general noise limits for commercial and industrial areas, and the Screening Ordinance provides for visual and noise buffers between residential and commercial land uses.

The City also has several policies that are aimed at noise abatement. Emergency vehicles can only use sirens in emergency situations. Contractors working for the City must keep noise at a minimum during construction and work only between 8 a.m. and 5 p.m., unless special permission is given. Sufficient property must be purchased for new electric power substations to maintain acceptable noise levels at property lines. In many areas of the city, trucks are rerouted out of residential neighborhoods. Sound barriers have been placed along parts of MoPac Expressway. Late-night athletic activities are restricted at parks.

Although Robert Mueller Airport is owned and operated by the City of Austin, airport administration has little authority over noise produced by aircraft. Airport staff meets regularly with Federal Aviation Administration officials to review noise problems. The following steps have been taken to mitigate noise problems:

- incoming aircraft do not descend until they are close to the airport, reducing noise in outlying areas

- power is reduced after take-off to minimize noise impact in the immediate vicinity of the airport

- airlines are encouraged to reduce flights between midnight and 6:00 a.m., and engine run-ups are prohibited between these hours, except in emergency situations

- vegetative noise barriers are promoted around the airport

Since the areas most affected by airport noise are already built up, it is too late to develop a compatible land use plan; however, land use controls can be imposed on new development and redevelopment. The City is considering the option of relocating the municipal airport to an outlying area.

4.1.19 Environmental Board

The Environmental Board was established by ordinance in 1971. The Board is an advisory body consisting of nine citizens of varied backgrounds appointed by the City Council for two-year terms. The Board reviews requests for variances to the City's environmental ordinances, considers environmental issues that affect the people of Austin, makes recommendations on standards and policy to the City Council, and initiates specific studies. The Environmental Board has mandatory meetings twice a month, but the Board often conducts more frequent meetings as needed. Meetings are open to public attendance.

4.1.20 Environmental Court

The Municipal Court recently designated one of its judges as Environmental Judge to handle all cases relating to violations of the City's environmental ordinances. The judge has a specialized knowledge of environmental regulations, and this provides for a greater consistency in legal interpretation and action. The establishment of the Environmental Court is a recognition of the City's emphasis on enforcing environmental protection measures, and assigns a higher priority to environmental cases by greatly expediting their processing.

4.1.21 Environmental Hot Line

The Environmental Hot Line was recently established to provide citizens with an express line to voice environmental complaints and concerns and to ask questions pertaining to environmental issues. One of the main purposes of the Hot Line is to immediately direct the calls received to the appropriate enforcement agency, so that the caller does not have to pursue an often frustrating chain of telephone referrals. The Hot Line is maintained and operated by the City's Department of Environmental Protection. The number of the Hot Line is 474-2368. Hot Line calls left on the telephone recorder will be returned promptly during regular weekday hours.

4.1.22 Department of Environmental Protection

Following a thorough review of the City's environmental programs, the City Manager recently announced the formation of a new City Department of Environmental Protection. This reorganization places more of the City's environmental programs under one department and underscores the City's commitment to environmental protection. The Department of Environmental Protection has many responsibilities, which include:

- participation in inter-agency review, including Texas Water Commission effluent permits, Texas Air Control Board emission permits, U. S. Army Corps of Engineers permits, and environmental impact statements for state and federal projects
- review of subdivisions, Capital Improvement Projects, and Municipal Utility Districts
- inspection of construction sites for tree protection and erosion and sedimentation controls
- groundwater and surface water quality monitoring
- community education programs
- natural resource inventory and mapping
- coordination of hazardous materials management

The Department of Environmental Protection is also involved in various aspects of environmental planning, such as technical input to Austinplan, the City's comprehensive planning initiative. DEP also provides technical support to the Environmental Board and to other departments and agencies.

4.1.23 Other Environmental Protection Measures

Environmental quality monitoring programs are also conducted by other City departments. The Electric Utility monitors water quality of power plant influent and effluent, and monitors air quality at the City's power plants.

The Water and Wastewater Utility monitors water quality of influent and effluent at the City's water and wastewater treatment plants.

The Water and Wastewater Utility has played an important role in the development of the new Center for Environmental Research, sponsored by the City of Austin, The University of Texas, and Texas A&M University. The Water and Wastewater Utility and the Parks and Recreation Department both have an Environmental Manager. PARD administers the Austin Nature Center, the Nature Preserve Program (see Section 3.7), and the Wildlife Rescue Program.

The Austin-Travis County Health Department is involved in a number of important activities in addition to its inspection of package treatment plants, landfills, and septic tanks. ATCHD operates programs for weed control, control of disease-carrying rodents and insects, unattended animal control, and investigation of pollution complaints.

In addition to its solid waste management activities, the Transportation and Public Services Department compiles and revises the City's Drainage Criteria Manual, and maintains information on watershed and floodplain boundaries. TAPSD also maintains drainage easements owned by the City, and coordinates the Keep Austin Beautiful Program, a public-private cooperative effort.

Community and regional planning very often involves environmental considerations. The Department of Planning and Growth Management coordinates Austinplan, the City's comprehensive planning initiative. DPGM also coordinates the City's Annexation Policy and prepares population projections. The Office of Land Development Services is also involved in planning, and administers Zoning Review and Subdivision Review. The Planning Commission is a sovereign body appointed by the City Council. The Planning Commission decides variance cases, taking into account recommendations of the Environmental Board.

4.2 Environmental Protection Measures of other Agencies

Several other agencies, at the county, regional, state, and federal levels, have established environmental protection measures that apply to the Austin area. Also, some other important environmental protection measures are being proposed. Many of these agencies are involved in the gathering and presentation of information that is essential to the understanding of the nature and extent of environmental problems and to the formulation of effective environmental regulations.

4.2.1 Federal Agencies

Several important pieces of federal environmental legislation have conferred broad powers to the Environmental Protection Agency (EPA). EPA establishes national standards and methods, and delegates much of its authority to appropriate state agencies, as will be discussed in subsequent sections.

Even though it is not a regulatory agency, the United States Geological Survey (USGS) plays an important role in providing information. USGS monitors surface water and groundwater resources, maintains data banks, prepares reports, and provides technical assistance. The USGS hs worked in cooperation with the City on water quality monitoring studies and mapping the southern Edwards Aquifer.

4.2.2 Texas Water Commission

The Texas Water Commission (TWC) receives its broad authority from EPA and the Texas Water Code. TWC regulates several aspects of environmental protection, including quality and quantity of surface water and groundwater resources, and management of hazardous wastes. TWC also maintains ongoing surface water and groundwater monitoring programs and inspection programs, provides data to the Texas Natural Resources Information System (TNRIS), and prepares reports.

TWC is authorized by EPA, through the Clean Water Act, to administer the National Pollution Discharge and Elimination System (NPDES), through which TWC establishes quality and quantity standards for effluent discharges to waters of the State. TWC is the permitting authority for effluent discharges. TWC also establishes quality standards and suitable uses for certain surface water resources of the State.

TWC has established some special rules concerning groundwater resources in Hays County and Williamson County. These rules are administered by the appropriate County Commissioners Court. Provisions of the rules require pollution abatement plans for new development projects, and establish guidelines for septic tanks, wastewater treatment plants, sewage lines, and underground storage tanks. TWC considered similar rules for Travis County, but decided that City of Austin ordinance power was sufficient to obviate the necessity of such rules.

TWC conducts application procedures for special law districts provided for by the Texas Water Code, including Municipal Utility Districts (MUD's), Water Conservation and Improvement Districts (WCID's), and Underground Water Conservation Districts.

TWC is authorized by EPA, through the Resource Conservation and Recovery Act, to administer the State Hazardous Waste Management Program. TWC is the permitting authority for hazardous waste management firms and maintains an inspection program.

4.2.3 Texas Air Control Board

The Texas Air Control Board (TACB) is authorized by EPA, through the Clean Air Act, to establish and administer air quality standards. TACB is the permitting and inspecting authority for point sources of air pollution, such as industries and electric power plants. TACB is also authorized to administer the implementation of pollution abatement and control plans for areas not in compliance with air quality standards. TACB maintains a statewide air quality monitoring network and prepares periodic reports. TACB also inspects air quality complaints.

4.2.4 Other State Agencies

Several other State agencies have been delegated by EPA to administer federal environmental legislation. The Texas Railroad Commission is authorized, through the Clean Water Act and the Safe Drinking Water Act, to regulate water pollution resulting from the exploration, development, and production of petroleum, natural gas, surface mining, and geothermal resources. The Texas Department of Health is authorized, through the Safe Drinking Water Act, to establish drinking water standards for public water supplies, review plans for construction of water and wastewater projects, and maintain surveillance over public water supplies. TDH also regulates landfills, occupational health and safety, septic systems, and radiation control. The Texas Department of Agriculture is authorized, through the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), to certify and regulate those substances, and monitor for residuals in waters of the State. The Texas Department of Public Safety is authorized, through the Clean Air Act, to administer the State Motor Vehicle Inspection Program. DPS may also issue citations to vehicles on the road that emit undue amounts of smoke or noise.

The Governor recently appointed a Select Committee to study water quality of the Colorado River downstream of Austin's municipal wastewater treatment plants. The Committee has recommended present and future effluent standards to insure improvement of water quality of the Colorado River.

4.2.5 Lower Colorado River Authority

The Lower Colorado River Authority (LCRA) was established by the State Legislature in 1934 to responsibly develop and protect that water resource.

The LCRA Board recently adopted a policy that placed a moratorium on further wastewater discharges to the Highland Lakes, and established stricter effluent standards for existing plants. LCRA also regulates and inspects septic tanks in its ten-county jurisdiction. LCRA includes a separate Environmental Division, which maintains an extensive water quality monitoring program and prepares reports.

4.2.6 Travis County

In addition to its important contribution to the operation of the Austin-Travis County Health Department, Travis County is involved in some other environmentally related activities. The County Engineer's Office oversees development projects in the County's jurisdiction, and generally takes into consideration environmental concerns expressed by the City of Austin. The County operates two solid waste transfer stations and regulates open burning. The County Agricultural Extension Office helps to promote soil conservation practices, and the County maintains a significant amount of parkland.

4.2.7 Proposed Environmental Protection Measures

Some important environmental protection measures are proposed for the Austin area, including sole-source aquifer designation for the southern Edwards Aquifer, an Underground Water Conservation District for the southern Edwards Aquifer, and a regional wastewater treatment facility for southern Williamson County.

Recent amendments to the Federal Safe Drinking Water Act allow EPA to make funds available to local governments for establishing programs to protect sole-source aquifers and wellhead areas. The City of Austin and other municipalities in the area have petitioned EPA for sole-source aquifer designation for the southern Edwards Aquifer, since that resource supplies at least 50 percent of the people in the area with drinking water. The designation would also require thorough investigation of the environmental impacts of federally-funded projects (such as highway construction) proposed in the area.

The Cities of Austin, Buda, Hays, San Leanna, and Sunset Valley, and the LCRA are currently sponsoring a proposal to create an Underground Water Conservation District for the southern Edwards Aquifer. Under Chapter 52 of the Texas Water Code, the proposed Barton Springs-Edwards Aquifer Conservation District would have specific powers to:

- develop plans for groundwater use, conservation, and prevention of waste
- conduct surveys and research
- regulate pumpage of water from wells and require permits for drilling and equipping of wells (with exceptions for low-volume wells)

- o regulate open or uncovered wells and illegal drilling or operation of wells

- o acquire land to build projects to enhance recharge of the aquifer

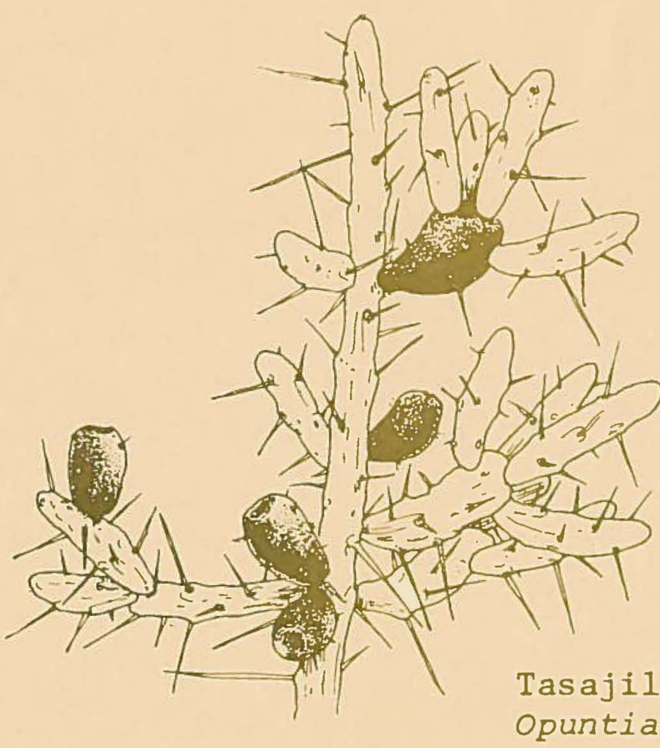
A regional wastewater treatment plant is proposed for the upper Brushy Creek watershed in southern Williamson County. The facility will discharge 10 MGD to Brushy Creek in 1987; ultimately, the regional plant will discharge 50 MGD, when the watershed is fully developed. This would make the affected segment of Brushy Creek dominated by effluent under normal streamflow conditions, but with stringent effluent quality standards, the overall water quality impacts should be less severe than those resulting from the continued proliferation of package treatment plants, which often have difficulties in adequately handling peak flows. The facility, to be built east of Round Rock, will provide service for Round Rock, the portion of Austin and its ETJ within Williamson County, and special water districts in the area. Part of the overall plan for the system is to reduce the amount of effluent discharged to the Colorado River at the City of Austin's Walnut Creek Plant.

5.0 CONCLUSION

Austin is located in an area rich in natural resources, characterized by a remarkable diversity in topography, geology, soils, and native plants and animals. But Austin's attractive quality of life has contributed to one of the highest population growth rates in the nation.

Increased urbanization poses a direct threat to the quality of the environment, which is an integral component of our quality of life. Surface water and groundwater resources are invaluable, but they are not available in inexhaustible supplies, and they are susceptible to contamination from a number of sources, including urban runoff, wastewater, and hazardous materials. Air quality and noise levels are directly affected by increasing air and vehicle traffic and construction activity. The amount of undisturbed natural habitat is significantly decreased by further land development, to the point that some species are vanishing from the area.

But the people of Austin have demonstrated a growing environmental awareness and a genuine concern for their natural surroundings, evidenced by the extensive measures enacted to protect environmental quality, such as the Comprehensive Watersheds Ordinance. There still remains some work to be done, but Austin now stands in the forefront among other major cities in terms of environmental protection.



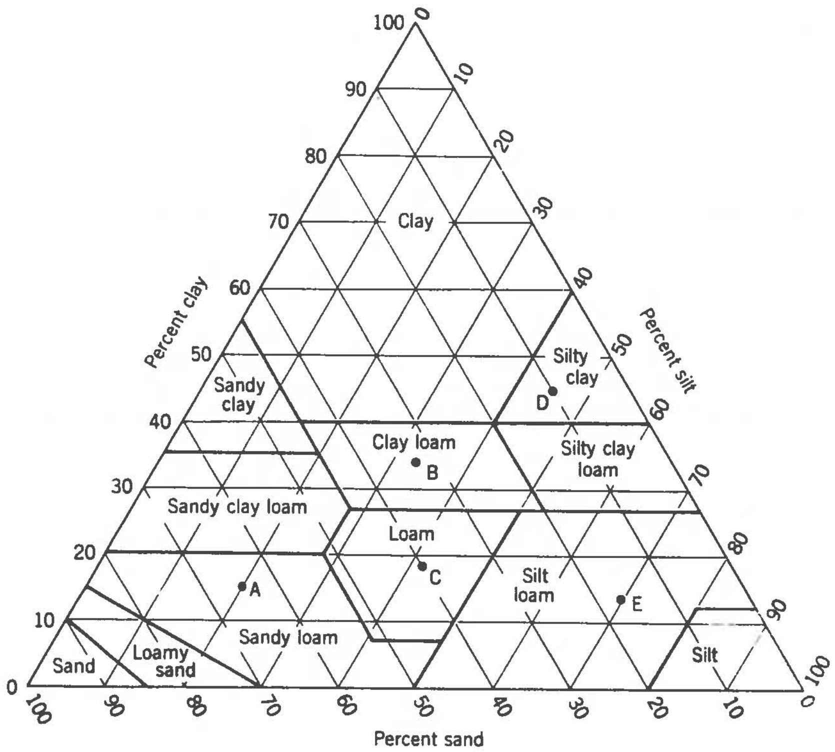
Tasajillo, or Pencil Cactus
Opuntia leptocaulis

Source: Lynch & McGowan, 1981
Native & Naturalized Woody Plants of Austin & the Hill Country

APPENDICES

Appendix A
SOIL TEXTURE GRADES

Name of Grade	Diameter. In	Diameter. Mm
Coarse gravel	Above 0.08	Above 2
Fine gravel	0.04–0.08	1–2
Coarse sand	0.02–0.04	0.5–1
Medium sand	0.01–0.02	0.25–0.5
Fine sand	0.004–0.01	0.1–0.25
Very fine sand	0.002–0.004	0.05–0.1
Silt	0.000,08–0.002	0.002–0.05
Clay	Below 0.000,08	Below 0.002



Source: Strahler, Physical Geography, 1975

Appendix B
NATIONAL AMBIENT AIR QUALITY STANDARDS

Carbon Monoxide (CO)	35 ppm hourly average 9 ppm eight hour average
Nitrogen Dioxide (NO_2)	0.05 ppm
Non-methane Hydrocarbons	0.24 ppm
Photochemical Oxidants	0.12 ppm hourly average measured as ozone
Total Suspended Particulate Matter	260$\mu g/m^3$ 24-hour average 75 $\mu g/m^3$ annual geometric mean
Sulfur Dioxide (SO_2)	365 $\mu g/m^3$ (0.14 ppm) 24-hour average 80 $\mu g/m^3$ (0.03 ppm) annual average
Lead (Pb)	1.5$\mu g/m^3$

Established by the
U.S. Environmental Protection Agency

Appendix C
TRIANGULAR SEDIMENT FILTER DIKES

Definition

A temporary barrier constructed of wire mesh and geotextile fabric, installed along a flat area, or across or at the toe of a slope.

Purpose

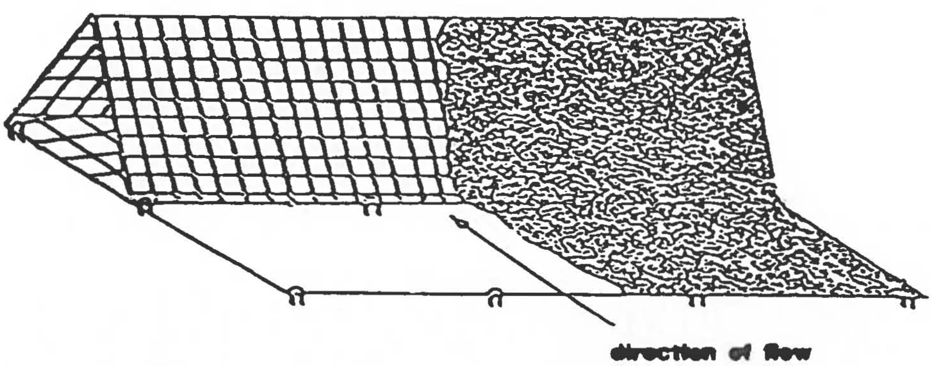
To intercept and detain water-borne sediment from unprotecccted areas of limited extent.

Applicability

- o where there is no concentration of water in a channel or other drainageway above the barrier; if concentrated flow occurs after installation, corrective action must be taken
- o where the contributing drainage area is less than one-half acre, and the length of slope above the dike is less than 100 feet

Design Criteria

All dikes should be placed on the contour and should be placed in a row, with ends tightly abutting the adjacent dike. Filter material should lap over ends six inches to cover dike-to-dike junction; each junction should be secured by shoat rings. The interceptor skirt should be weighted down with a continuous layer of three- to five-inch open graded rock, or toed-in six inches with compacted material; otherwise, the entire dike structure should be trenched in four inches.



The maximum flow-through rate should not exceed 20 gal/min/ft frontal area. The frame should be made of 6x6-inch, 6 ga. wire mesh, in an equilateral triangle 18 inches to a side, secured at apex junction. Filter material should be non-woven polypropylene, polyethylene, or polyamide geotextile fabric, minimum unit weight of 4.5 oz/sy, mullen burst strength exceeding 250 psi, ultraviolet stability exceeding 70 percent, and equivalent opening size exceeding 40. The fabric cover and skirt should be a continuous wrapping of the fabric. The skirt should be a continuous extension of the upstream face, and have a minimum length of 12 inches.

Inspection will be frequent, and repair or replacement should be made promptly as needed. Accumulated silt should be removed when it reaches a depth of six inches, and disposed of in a manner which will not cause additional siltation. After the development site is completely stabilized, the dikes and accumulated silt should be removed; silt should be disposed of in an approved spoils disposal site.

Appendix D
SOME USEFUL REFERENCES ON THE ENVIRONMENT OF THE AUSTIN AREA

SURFACE WATER RESOURCES

Austin Creeks.
City of Austin, 1976.

Expanded Floodplain Information for Walnut Creek.
U.S. Army Corps of Engineers, 1980.

Expanded Floodplain Information for Williamson Creek.
U.S. Army Corps of Engineers, 1980.

Flood Hazards along the Balcones Escarpment in Central Texas: Alternatives to their Recognition, Mapping, and Management.
Univ. of Texas, Bureau of Economic Geology, 1975.

Floodplain Information for Big and Little Walnut Creeks.
U.S. Army Corps of Engineers, 1972.

Floodplain Information for Bull Creek.
U.S. Army Corps of Engineers, 1976.

Floodplain Information for Onion Creek.
U.S. Army Corps of Engineers, 1973.

Floodplain Information for the Colorado River and Country Club Creek.
U.S. Army Corps of Engineers, 1976.

Floodplain Information for the Colorado River and Onion Creek.
U.S. Army Corps of Engineers, 1976.

Floodplain Information for Williamson Creek.
U.S. Army Corps of Engineers, 1973.

Hydrologic Data for Urban Studies in the Austin, Texas Metropolitan Area.
U.S. Geologic Survey, Annual Publication.

Preliminary Ecological Assessment of Waller Creek.
URS/Forrest & Cotton, Inc., and Espey, Huston & Associates, Inc., 1975.

Study of Some Effects of Urbanization on the Barton Creek Watershed.
Espey, Huston & Associates, Inc., 1979.

Walnut Creek Watershed Environmental Management and Planning Study.
City of Austin, 1985.

Walnut Creek Watershed Survey.

U.S. Army Corps of Engineers, 1982.

Water Resources Data for Texas, Vol. 3.
U.S. Geological Survey, Annual Publication.

Watershed Monitoring by Remote Sensing.
City of Austin, 1984.

GROUNDWATER RESOURCES

Edwards Aquifer, Northern Segment.
Austin Geological Society, Guidebook #8, 1985.

Edwards Group, Surface and Subsurface, Central Texas.
Univ. of Texas, Bureau of Economic Geology, 1972.

Effects of Stormwater Runoff on Water Quality of the Edwards Aquifer Near Austin, Texas.
U.S. Geological Survey, 1984.

Facts and Information on the Northern Edwards Aquifer.
City of Austin, 1986.

Final Report on the South Austin Metropolitan Area of the Edwards Aquifer.
City of Austin, 1983.

Geohydrology of the Edwards Aquifer in the Austin Area, Texas.
Texas Water Development Board, 1986.

Guide to the Regional Mapping Project of the Edwards Aquifer Associated with Barton Springs.
City of Austin, 1985.

Hydrogeology of the Edwards Aquifer, Barton Springs Segment.
Austin Geological Society, Guidebook #6, 1984.

Hydrology and Water Quality of the Edwards Aquifer Associated with Barton Springs in the Austin Area, Texas.
U.S. Geological Survey, 1986.

Hydrology of the Edwards Aquifer, Austin Area, Central Texas.
Univ. of Texas, Bureau of Economic Geology, 1984.

Major and Historical Springs of Texas.
Texas Water Development Board, 1975.

Occurrence, Availability, and Quality of Groundwater in Travis County, Texas.
Texas Dept. of Water Resources, 1983.

Recharge Zone of the Edwards Aquifer Hydrologically Associated with Barton Springs in the Austin Area, Texas.
U.S. Geological Survey, 1986.

Simulation of the Flow System of Barton Springs and Associated Edwards Aquifer in the Austin Area, Texas.
U.S. Geological Survey, 1985.

Texas Groundwater Protection Activites.
Texas Water Commission, 1986.

Water, Water Conservation, and the Edwards Aquifer.
Southwest Texas State Univ., Edwards Aquifer Research and Data Center, 1981.

RUNOFF AND RUNOFF CONTROLS

Erosion and Sedimentation Control Manual.
City of Austin, 1982 (supp. 1986).

Erosion and Sediment Control Guidelines for Developing Areas in Texas.
U.S. Dept. of Agriculture, Soil Conservation Service, 1976.

Final Report of the Nationwide Urban Runoff Program in Austin, Texas.
City of Austin, 1983.

Revegetation Guidelines for the City of Austin.
Espey, Huston & Asoociates, 1976.

Stormwater Quality Modeling Study for Austin Creeks.
City of Austin, 1983.

Streamside Vegetative Filters.
City of Austin, 1986.

GEOLOGY

Environmental Geology of the Austin Area: An Aid to Urban Planning.
Univ. of Texas, Bureau of Economic Geology, 1976.

Guidebook to the Geology of Travis County.
Univ. of Texas, Student Geological Society, 1977.

Guide to Points of Geologic Interest in Austin.
Univ. of Texas, Bureau of Economic Geology, 1983.

Land Resources Overview of the Capital Area Planning Council Region Texas: A Non-Technical Guide.
Univ. of Texas, Bureau of Economic Geology, 1979.

SOILS

Soil Survey of Travis County.

U.S. Dept. of Agriculture, Soil Conservation Service, 1974.

Soil Survey of Williamson County.
U.S. Dept. of Agriculture, Soil Conservation Service, 1983.

Soil Survey of Comal and Hays Counties.
U.S. Dept. of Agriculture, Soil Conservation Service, 1984.

PLANTS

Common Texas Grasses: An Illustrated Guide.
Frank W. Gould, 1978.

Field Guide to Southwest and Texas Wildflowers.
Theodore F. Niehaus & Charles E. Ripper, 1984.

Identification Guide for Wetlands in the Austin Area.
City of Austin, 1986.

Identification of Woody Plants for the Wild Basin Preserve and the Nearby Hill Country.
Judy Walther, 1981.

Native and Naturalized Woody Plants of Austin and the Hill Country.
Brother Daniel Lynch, 1981.

Plants of Austin, Texas.
Brother Daniel Lynch, 1974.

Quantitative Descriptive Study of the Grassland Vegetation and Soils of the Eastern Edwards Plateau, Texas.
Espey, Huston & Associates, Inc., 1983.

Southern Fern Guide.
Edgar T. Wherry, 1964.

Tree Registry for Austin, Texas.
City of Austin, 1976.

Trees of Central Texas.
Robert A. Vines, 1984.

Trees, Shrubs, and Woody Vines of the Southwest.
Robert A. Vines, 1960.

Wildflowers of Texas.
Geyata Ajilvsgi, 1984.

ANIMALS

Bird Finding and Naturalists Guide for the Austin, Texas, Area.

Edward A. Kutac & Christopher S. Caran, 1976.

Field Guide to the Birds of Texas.
Roger Tory Peterson, 1963.

Golden-Cheeked Warbler: A Bioecological Study.
Warren M. Pulich, 1976.

Lake Austin Wildlife Unit, Travis County, Texas: The Land and the Wildlife.
Texas Dept. of Parks and Wildlife, 1983.

Texas Mammals East of the Balcones Fault Zone.
David J. Schmidly, 1983.

AIR QUALITY

Data Summary for Continuous Air Monitoring Network.
Texas Air Control Board, Annual Publication.

Data Summary for Non-Continuous Air Monitoring.
Texas Air Control Board, Annual Publication.

NOISE

Air Installation Compatible Use Zone Study.
Bergstrom Air Force Base, 1985.

Noise in Austin, Texas.
Tracor, Inc., 1974.

Substation Noise Study.
City of Austin, 1976.

WASTE DISPOSAL

Cumulative Effects of Wastewater Discharges on Water Quality in the Austin and Travis County Region.
City of Austin, 1985.

Landfills in the Vicinity of Austin, Texas.
Underground Resource Management, Inc., 1984.

Wastewater Disposal Facilities in Hays, Williamson, and Travis Counties.
City of Austin, 1985.

Wastewater Alternatives for the Barton Creek Watershed.
Parkhill, Smith & Cooper, Inc., 1985.

Water and Wastewater Master Plan for the City of Austin.
Metcalf & Eddy, Inc., 1982.

RESOURCE CONSERVATION

Austin's Conservation Power Plant.
City of Austin, 1985.

Austin's Water Management Plan.
City of Austin, 1985.

Resource Recovery Implementation Plan for the City of Austin, Texas.
Henningson, Durham & Richardson, Inc., 1982.

Xeriscape: Water and Energy Conservation through Creative Landscaping.
City of Austin, 1985.

ENVIRONMENTAL REGULATIONS

Annexation Plan.
City of Austin, 1982.

Code of the City of Austin.
Municipal Code Corp., 1981 (supp. 1985).

Environmental Statutes.
Government Institutes, Inc., Annual Publication.

Guide to Texas Environmental Regulatory Programs.
Texas Energy and Natural Resourcers Advisory Council, 1982.

Texas Water Code.
West Publishing Co., 1986.

GENERAL

Austin Tomorrow Plan: Environmental Technical Report.
City of Austin, 1974.

Environmental Progress Report.
City of Austin, 1982.

Growth Watch.
City of Austin, Quarterly Publication.

Management Options for Austin's Nature Preserves.
Univ. of Texas, Community and Regional Planning Program, 1984.

Quality of Life: Austin Trends, 1970-1990.
Univ. of Texas, Community and Regional Planning Program, 1984.

Recreational and Natural Areas Guide: Austin Subregion of the Edwards Aquifer.

Southwest Texas State Univ., Edwards Aquifer Research and Data Center, 1984.

Wild Landscape of the Edwards Plateau of South Central Texas: A Study of Developing Livelihood Patterns and Ecological Change.
James A. Schmid, 1969.

Appendix E
ENVIRONMENTAL ORGANIZATIONS IN THE AUSTIN AREA

AUSTIN NEIGHBORHOODS COUNCIL
Susan Toomey Frost
806 Rosedale Terrace
Austin, TX 78704-3159
447-2575

AUSTIN ORGANIC GARDENERS
John Dromgoole
6804 Old Bee Cave Rd.
Austin, TX 78735
288-2648

CENTER FOR ENVIRONMENTAL EDUCATION
1201 W. 24th St.
Austin, TX 78705
477-6424

CENTER FOR MAXIMUM POTENTIAL BUILDING SYSTEMS
Pliny Fisk
8604 FM 969
Austin, TX 78724
928-4786

CENTRAL TEXAS HAZARDOUS WASTE MANAGEMENT SOCIETY
Charlie Faulds
c/o Jones & Neuse
2720 Bee Cave Rd.
Austin, TX 78746
327-9840

CLEAN CLEAR COLORADO
Robert McCurdy
802 Rutherford Place
Austin, TX 78704
447-3014

COMMUNITY GARDENS
Waunda Stedman
4814 Sunshine Dr.
Austin, TX 78756
458-2009

ECOLOGY ACTION COMMUNITY RECYCLING
Bill Carter
600 W. 28th St., #202
Austin, TX 78705
478-1645

FRIENDS OF THE PARKS
Susan Toomey Frost
806 Rosedale Terrace
Austin, TX 78704-3159
447-2575

HILL COUNTRY FOUNDATION
Bill Collier
1104 Nueces
Austin, TX 78701
478-5743

KEEP AUSTIN BEAUTIFUL
Alan Watts
505 Barton Springs Rd.
Austin, TX 78704
499-7048

LEAGUE OF WOMEN VOTERS OF AUSTIN
Christina Little
1011 W. 31st St.
Austin, TX 78705
451-6710

MOBILIZATION FOR SURVIVAL
Dan Harrison
1022 W. 6th St.
Austin, TX 78703
474-5877

NATIONAL WILDFLOWER RESEARCH CENTER
Dr. David Northington
2600 FM 973
Austin, TX 78725
929-3600

NATIVE PLANT SOCIETY
Jim & Wanda Holmes
8401 Bell Mountain Dr.
Austin, TX 78730
346-2518

PROTECT LAKE TRAVIS ASSOCIATION
Cecil Laws
8400 MoPac, Suite 304
Austin, TX 78759
267-1918

SAVE AUSTIN'S NEIGHBORHOODS AND ENVIRONMENT (SANE)
Clifton Griffin
2207 S. Lakeshore Blvd.
Austin, TX 78741
442-9455

SAVE BARTON CREEK ASSOCIATION
Jane Anderson
2606 Rae Dell
Austin, TX 78704
443-8909

SAVE BEAR CREEK/SAVE ONION CREEK COALITION
JoAnn Hawbaker
4702 Indian Wells Dr.
Austin, TX 78747
282-5748

SAVE-OUR-LAKE ASSOCIATION
Charles C. Cleland
3427 Monte Vista
Austin, TX 78731
453-6403

SIERRA CLUB
Nancy Fuentes
600 W. 28th St., #202
Austin, TX 78705
478-1264

TEXANS FOR CLEAN WATER
Will Boettner
c/o Radian Corp.
P.O. Box 9948
Austin, TX 78766
454-4797

TEXAS CENTER FOR RURAL STUDIES AND
TEXAS PESTICIDE PROJECT
Leslie Kochen
P.O. Box 2618
Austin, TX 78767
474-0811

TEXAS ENVIRONMENTAL COALTION
600 W. 28th St.
Austin, TX 78705
476-3961

TEXAS SPELEOLOGICAL ASSOCIATION
Mike Warton
c/o DDY Consulting Engineers
3807 Spicewood Springs Rd., Suite 100
Austin, TX 78759
345-3560

TEXAS WATER CONSERVATION ASSOCIATION
Leroy Goodson

206 San Gabriel Bldg.
Austin, TX 78701
472-7216

TOWN LAKE PARK ALLIANCE
Ray Reece
908 Ebony
Austin, TX 78704
442-3630

TRAVIS AUDUBON SOCIETY
1030 E. 43rd St.
Austin, TX 78751
451-3308

WALNUT CREEK ALLIANCE
Janet Klotz
11100 Terrace Bluff
Austin, TX 78754
837-5600

WE CARE AUSTIN
Eva Wisser
6401 Shadow Valley Dr.
Austin, TX 78731
343-0660

WESTCAVE PRESERVE
John Ahrns
Star Route 1-A, Box 30-C
Dripping Springs, TX 78620
825-3442

WILD BASIN WILDERNESS
Mark Bierner
802 Brazos
Austin, TX 78701
476-4113

Appendix F
AGENCIES INVOLVED IN ENVIRONMENTAL CONCERNS
IN THE AUSTIN AREA

CITY OF AUSTIN

Austin-Travis County Health Department, 469-2000
  Environmental Health Services, 469-2015
    (weed control, rodent and vector control, animal control, septic systems, air and water pollution)

Environmental Protection Department, 499-2550
  Environmental Services, 499-2760
    (review of development projects, construction inspection)
  Environmental Resource Management, 499-2550
    (water and air quality, biological and geological resources, environmental planning, Erosion and Sedimentation Control Manual, inter-agency permit review)

Fire Department, 472-9201
  Hazardous Materials Unit, 443-0976

Office of Land Development Services, 499-2640
  Zoning, 499-2680
  Planning, 499-2400

Parks and Recreation Department, 477-7273
  Heritage and Conservation, 327-8180
    (Austin Nature Center, Nature Preserves Program)
  City Forester, 445-4414
  Environmental Manager, 499-6754
  Wildlife Rescue, 472-9453

Planning and Growth Management Department, 448-0944
  (Austinplan process, "Growth Watch")

Resource Management Department, 441-9240
  (water and energy conservation, Xeriscape)

Transportation and Public Services Department, 499-7058
  Watershed Management, 499-7102
    (watershed and floodplain boundaries, Drainage Criteria Manual)
  Recycling Hot Line, 479-6753
  Solid Waste Services, 472-0500

Water and Wastewater Utility, 445-3000
  Industrial Waste Control, 926-0316
  Environmental Manager, 445-3076

TRAVIS COUNTY

County Engineer, 473-9122
(hydrology, development permits, septic tanks, solid waste)

Agricultural Extension Office, 473-9600
Rodent Control, 473-9613

REGIONAL AGENCIES

Capital Area Planning Council, 443-7653

Edwards Aquifer Research and Data Center, (512)245-2329

Greater Austin and San Antonio Corridor Council, (512)245-2535

Lower Colorado River Authority, 473-3200
Environmental Quality, 473-3214
Natural Resources Policy and Programs, 473-3214

STATE AGENCIES

Texas Air Control Board, 451-5711

Texas Department of Agriculture, 463-7476
Pesticide Regulation, 463-7547

Texas Attorney General's Office, 463-2100
Environmental Protection Division, 463-2012

Texas Conservation Foundation, 463-2196

Texas General Land Office, 463-5001
Energy Resources, 463-5008
Land Management, 463-5211
Beach Protection Program, 463-5053

Texas Department of Health, 458-7111
Occupational Health, 458-7254
Radiation Control, 835-7000
Solid Waste Management, 458-7271
Water Hygiene, 458-7533

Texas Parks and Wildlife Department, 389-4800
Pollution Surveillance, 389-4726
Species Status, 389-4979

Texas Department of Public Safety, 465,2000
Nuclear Waste Program, 463-2198
Nuclear Protection Planning, 451-4727

Texas Water Commission, 463-7830
Environmental Coordinator, 463-7907
Groundwater Conservation Program, 463-8273
District 14 Office, 463-7803
(inspection and enforcement in the Austin area)
Hazardous and Solid Waste, 463-7760
Water Quality, 463-8412

Texas Water Development Board, 463-7869
Environmental Systems, 463-7932
Water Availability, 463-8002
Texas Natural Resource Information System, 463-8337

FEDERAL AGENCIES

U.S. Department of Agriculture
Soil Conservation Service, 482-5591

U.S. Environmental Protection Agency
Region 6 Office, (214)767-2600

U.S. Department of Commerce
National Weather Service, 476-4993

U.S. Department of the Interior
Geological Survey, 482-5566
Bureau of Reclamation, 482-5641

U.S. Department of Labor
Occupational Safety and Health Administration, 482-5783

GLOSSARY

G L O S S A R Y

acid deposition. A type of air pollution in which acidic compounds are deposited on surface features; acid rain.

air mass. A large parcel of air that has relatively homogeneous moisture and temperature characteristics associated with its origin over a certain land or water surface.

alluvial. Referring to a stream.

alluvium. The sediments borne and deposited by a stream.

ambient air quality. Air quality that is assumed to be representative of a large area.

amphibian. A cold-blooded animal, such as a toad or frog, that is born in the water with gills and then transforms into an air-breathing land creature.

annexation. A legal means through which a city acquires additional territory, in which it can impose its full jurisdiction and levy taxes, and is required to provide municipal services.

aquifer. A permeable rock unit that can store and transmit groundwater in sufficient quantities to supply water to wells and springs.

artesian. Referring to confined groundwater under pressure.

bad-water line. An aquifer boundary, determined to be where groundwater is not fresh, generally where groundwater contains more than 1000 mg/l total suspended solids.

basalt. A hard, dark, dense, fine-grained extrusive igneous rock.

base flow. The normal flow of a stream, contributed by groundwater discharges, not stormwater runoff.

bearing strength. Capability of a soil to support a structural load without deforming.

berm. A barrier of rocks or brush used to control stormwater runoff.

bluff. A cliff or an abruptly steep slope.

bottomland. Land in or near the floodplain of a stream, usually flat with deep, alluvial soils.

brackish. Referring to water that is intermediate in salinity between fresh water and sea water.

buffering capacity. Ability of a substance to naturally counteract acidity.

calcareous. Consisting of or containing calcium carbonate.

caliche. A whitish crust on the ground that forms when groundwater is brought up to the surface by capillary action and evaporates, leaving behind mineral salts, particularly calcium carbonate.

canyon. A deep, steep-sided channel carved out of the earth's surface by moving water.

cavern. A cavity or chamber under the surface of the earth, caused by the dissolution of limestone by water.

chalk. A soft limestone.

clay. Soil with particles less than 0.002 mm in diameter; or, a soft rock composed of extremely fine mineral particles, called colloids.

climate. Atmospheric conditions averaged over a long period of time.

confined aquifer. An aquifer that is overlain by and under artesian pressure from a relatively impervious layer of rock.

corporate limits. The areal extent of a city's full jurisdiction.

decibel. A measurement of noise levels, representing the ratio of a particular sound intensity to the threshold of hearing.

discharge. The release of groundwater to the surface, either naturally through springflow or through pumpage.

dissection. The process through which moving water transforms a relatively uniform landscape into one characterized by hills and ravines.

dissolution. The chemical decomposition of earth material by exposure to water.

dissolved solids. Solids that are so fine they cannot normally be filtered out of a solution.

dolomite. Limestone that has been chemically altered by the intrusion of magnesium compounds.

easement. Land paralleling a roadway or drainageway reserved for improvements, that is owned by the City, but is used and maintained by the adjacent property owner.

ecology. The relationship between an organism and its environment.

ecosystem. The complex of a community of organisms in a natural environment.

effluent. Outflow of treated wastewater.

elevation. Distance above sea level; altitude.

endemic. Restrticted to or characteristic of a certain location or area; native to.

environment. The physical surroundings.

erosion. The physical decomposition of earth material.

escarpment. A long cliff or steep slope caused by erosion or faulting.

estuarine. Referring to the shallow-water environment at the mouth of a river, where fresh water and sea water merge.

evaporites. Sediments left behind after a solution is evaporated.

evapotranspiration. The loss of soil moisture through a combination of evaporation directly from the soil surface and transpiration from plants rooted in the soil.

expansive soils. Soils that largely contain clays that shrink and swell with changes in soil moisture.

extraterritorial jurisdiction. The area beyond the incorporated territory of a city, in which the city can still impose partial jursidiction.

fault. A fracture in the earth's surface, which may result in a vertical displacement of stratigraphic units.

fauna. Animal life.

floodplain. The land area adjacent to a stream that may be inundated during flood events.

flora. Plant life.

forage. The food on which an animal browses or grazes.

formation. A layer of the earth's crust that is composed of distinctive rock features.

front. The interface or boundary between two different air masses.

gabion. A box formed of wire mesh filled with rocks used to reinforce a stream bank.

geology. Study of the structure of the earth and its natural history.

geothermal. Referring to heat derived from natural processes within the earth.

gilgai. Small mounds that develop in an otherwise flat terrain, when cracks in expansive soils fill in with sediment and then close over.

grandfather. To exempt a development project from the provisions of an ordinance passed after the project was already approved.

gravel. Soil with particle sizes greater than 1.0 mm in diamter.

groundwater. Water contained in the earth's crust.

group. A broad layer of the earth's crust comprised of two or more geologic formations.

habitat. The typical physical environment in which an organism lives.

heavy metals. Particles of metals such as copper, iron, zinc, chromium, mercury, and cadmium that are carried in urban runoff and tend to accumulate in stream bottom sediments and fish tissue.

humus. The dark top layer of soil derived through the decomposition of organic matter.

hundred-year flood. A flood event of such magnitude that it would be expected to occur only once every 100 years.

hurricane. A tropical storm with windspeeds greater than 75 mph.

hydric. Referring to soils that are saturated with water.

hydrophytic. Referring to plants that require an abundance of moisture.

igneous. Referring to rocks that form through the consolidation of molten earth materials.

impervious. Unable to transmit water.

indigenous. Occurring naturally in a certain location or area.

intermittent. Referring to a stream or spring that only flows part of the time, usually during periods of signficant rainfall.

karstic. Relating to a landscape shaped largely through the dissolution of limestone by water.

latitude. Distance north or south of the equator.

lignite. A coal lower in quality than anthracite and bituminous, with a higher sulfur content.

limestone. A sedimentary rock composed chiefly of the mineral calcite, $CaCO_3$.

limited-purpose annexation. Means through which a city acquires additional territory, in which it can impose its full jurisdiction, but cannot levy taxes, and is not required to provide municipal services.

loam. Soil that is composed of some mixture of sand, silt, and clay.

mammal. A warm-blooded animal, such as a raccoon or deer, that nourishes its young with milk secreted from mammary glands and has skin more or less covered with hair.

member. A discrete rock unit that is part of a geologic formation.

mesic. Referring to or requiring a moderate amount of moisture.

metamorphic. Referring to rocks that have been changed in form through exposure to heat and pressure.

micro-releif. A relatively level landscape covered with small mounds and shallow depressions.

migratory bird. A bird that travels some distance according to changes of season.

mineral. A naturally formed solid substance having a definite chemcial composition and a characteristic internal form.

montmorillonite. A fine clay mineral that expands and contracts with changes in soil moisture.

moratorium. A legally imposed suspension of activity.

non-point source. A source of air or water pollution, such as urban runoff or vehicle emissions, not easily traced to a specific point.

nutrients. Compounds, such as nitrogen and phosphorus in effluent, that can be used as food by living organisms.

organic. Referring to or derived from living organisms; containing carbon.

outcrop. An area where a rock unit is exposed at the surface.

ozone. An unstable molecule, O_3, naturally formed in the upper atmosphere, and formed at the surface, where it is considered an air pollutant, when sunlight acts on vehicle emissions.

package plant. A small wastewater treatment plant, many components of which come pre-assembled.

parameter. A criterion used for poLlution analysis.

parent material. The rock unit from which a soil was formed.

percolate. Infiltrate or gradually seep into the ground.

permeable. Able to transmit water.

perennial. Referring to a stream or spring that always has some flow, even in dry seasons.

pH. A measurement of acidity, ranging from 0 to 14, with 7 being neutral; low pH values indicate acidity and high pH values indicate alkalinity.

photochemical haze. Blanket of air pollution near the surface caused by sunlight acting on certain air pollutants.

physical. Natural.

plain. An extensive land area having a relatively level surface.

plasticity. Measurement of a soil's tendency to deform under stress.

plateau. A plain raised above adjacent land; tableland.

point source. A specific source of pollution, such as a smokestack or treatment plant outfall.

potable. Drinkable.

prairie. A plain with deep, fertile soils, covered predominantly with tall grasses and having few trees.

ravine. A steep-sided channel carved out of the earth's surface by moving water, not as deep as a canyon, but deeper than a gully.

recharge. Water that infiltrates the ground and replenishes groundwater supplies.

relief. The difference in elevation over an area.

reptile. An air-breathing animal, such as a snake or turtle, with a body covered with scales or bony plates, that either crawls on its belly or has small, short legs, and has a body temperature and metabolism that can vary significantly with changes in ambient temperature.

resident bird. A bird that remains in the same area during all seasons of the year.

rimrock. Outcrop of a hard limestone layer paralleling the side of a canyon or surrounding a canyon head.

riparian. Referring to the banks of a stream.

rip-rap. A covering of rocks or cement used to stabilize a slope,

rock. A mass of mineral components, coherent to some degree, that constitutes part of the earth's crust.

__runoff__. Stormwater that flows overland instead of infiltrating the ground.

__salinity__. The amount of dissolved solids in a solution; saltiness.

__sand__. Soil with particle sizes between 0.05 and 1.0 mm in diamater.

__sanitary sewer__. System of pipes that connects homes, businesses, and other wastewater generators with a treatment plant.

__saturated zone__. That part of an unconfined aquifer below the water table.

__savana__. A tropical or subtropical grassland with scattered groups of xerophytic trees and understory.

__sediments__. Mineral particles that can be transported by moving water, air, or ice.

__sedimentary__. Referring to rocks that are formed through the deposition and consolidation of sediments.

__seep__. A natural point of trickling groundwater discharge.

__setback__. The placement of construction some distance from a determined line or feature.

__shearing__. Movement of one soil mass against another, parallel to the plane of contact.

__shelter cave__. A recess in the side of a cliff, often under an overhang.

__silt__. Soil with particle sizes between 0.002 and 0.05 mm in diamter.

__sinkhole__. An indented surface feature associated with a collapsed cavern.

__slickensides__. Parallel striations in expansive clay soils that are evidence of shearing.

__slope failure__. Massive movement of earth material downslope; landslide.

__sludge__. Materials that are settled out or chemically precipitated during the wastewater treatment process.

__soil__. Rock that has been weathered sufficiently to support rooted plants.

__soil association__. A group of associated soil series.

__soil creep__. Gradual gravitationmal movement of plastic soils downslope.

__soil series__. A specific local soil type.

__solution__. A liquid that contains suspended solids.

__spring__. A natural point of flowing groundwater discharge.

stormsewer. A curb inlet that conducts stormwater runoff to a stream or drainage channel.

stratigraphy. Branch of geology that deals with layers of the earth's crust.

subdivision. A parcel of land that has been divided into smaller lots.

subterranean. Underground.

subtropical. Having a latitude between the Tropic of Cancer or Capricorn and the mid-latitudes.

suspended particulates. Air-borne particles, such as pollen, dust, and vehicle and smokestack emissions.

suspended solids. Solids that can be filtered out of a solution.

tallus. Loose rock found on a slope or accumulated at the base of a slope.

temperature inversion. A stable condition in the lower atmosphere in which air temperature increases with an increase in altitude, inhibiting vertical air movement and significant cloud formation.

terrace. A bench in the terrain above the present floodplain of a stream, associated with floodplain levels in an earlier stage of the stream's development.

terrain. The landscape.

terra rossa. A reddish clay that is formed through the oxidation of evaporites left behind in limestone rocks.

topography. The form or contour of the terrain; the lay of the land.

tributary. A branch of a stream.

troglobite. An obligate cave organism, one that cannot live outside of a cave environment.

tropical. Having a latitude between the Tropic of Cancer or Capricorn and the equator.

tuff. A rock formed out of compacted volcanic fragments.

turbidity. A measurement of suspended solids; murkiness.

ultra-violet. A high-energy, short-wavelength radiation that, in sufficient amounts, may be harmful to living organisms.

unconfined aquifer. An aquifer that crops out at the surface and is under water table conditions.

unsaturated zone. That part of an unconfined aquifer above the water table.

upland. Land area above the floor of a stream valley.

uraniferous. Containing uranium.

valley. A depressed land area between ranges of hills or mountains, formed by moving water or ice.

vegetative assemblage. A group of associated plants normally found in a certain physical environment.

vugular. Referring to limestone honeycombed with small holes, caused by the dissolution of bore holes of ancient sea creatures.

watershed. The land area that contributes stormwater runoff to a particular stream; basin.

water table. The interface between the saturated zone and the unsaturated zone of an aquifer.

weather. The atmospheric conditions at a particular time.

weathering. The process through which earth material is decomposed by physical, chemical, and biological agents.

wellhead. Structural covering of a well, to protect the groundwater supply from contamination at that point.

wetland. A land area characterized by water-saturated soil, supporting a hydrophytic vegetative assemblage.

xerophytic. Referring to plants adapted to a limited water supply, through storing water and reducing transpiration; drought-resistant.

yield. The amount of water a well will produce.

zoning. The power of a city to regulate specific land uses within its corporate limits.